**United States Military Academy**

**West Point, New York 10996**

# Modeling and Simulation Terrain Database Management

**OPERATIONS RESEARCH CENTER OF EXCELLENCE**
**TECHNICAL REPORT DSE-R-0504**
**DTIC #: ADA435760**

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Analyst, Operations Research Center

Senior Investigators
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Associate Professor, Department of Systems Engineering

Directed by
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Director, Operations Research Center of Excellence

Approved by
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# Abstract

The modeling and simulation (M&S) community relies on terrain databases to provide the underpinnings that drive analysis, acquisition, and training. Terrain database generation is cost and time prohibitive. Furthermore, the problem of organizing these terrain databases is much more difficult than maintaining a catalog of paper maps. Reuse of terrain databases is hampered by the difficulty in identifying and accessing existing terrain databases with potential for reuse. Terrain databases not only vary by the geographic extents which they encompass but also vary by terrain database format as required by different simulation programs and platforms, by the amount of detail in terms of features and attributes contained, and by the resolution and fidelity among other factors. Thus, there may be several different terrain databases for the same geographic location but not all may be useful for particular M&S or for specific studies and analysis. This report discusses the application of the Systems Engineering and Management Process (SEMP), taught by the Department of Systems Engineering at the United States Military Academy, in developing a metadata framework for organizing these terrain databases as a means to facilitate reuse and reduce redundancy. Specifically, we focus on choosing among potentially dozens of descriptive metadata fields, considering the need for easy search capability as well as initial data entry. We also discuss related initiatives within the community.

# About the Author(s)

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# Acknowledgements

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Our mention of contributors does not imply their approval of our results. The opinions contained herein are the opinions of the authors and do not necessarily reflect those of BCSE, the United States Military Academy, the United States Army, or the Department of Defense.

# Table of Contents

# List of Figures



# List of Tables

# Chapter 1: Introduction

## *1.1 Background*

The United States Army uses modeling and simulation (M&S) for a wide array of purposes, ranging from materiel acquisition to doctrinal and force structure analysis, to soldier training to wargaming tactical courses of action. There are numerous M&S used for these applications. Terrain databases provide the information about the environmental conditions of a particular location and are utilized by the M&S to execute the simulation.

Terrain database generation is cost and time prohibitive. Furthermore, the problem of organizing these terrain databases is much more difficult than maintaining a catalog of paper maps. These databases are similar to maps: they contain the information about the relief, vegetation, hydrology, as well as man-made features, of a location. However, they are dissimilar from maps in that each one may have only portions of any of that information, at varying levels of detail, or the data may have been customized by a previous developer. Further, each M&S requires its own language or format. The result is that there can be several dozen unique terrain databases for a single geographic location.

Reuse of terrain databases is hampered by the difficulty in identifying and accessing existing terrain databases with potential for reuse. Unfortunately, Army analysts who need a particular area or set of terrain features must rely on their own collection of databases, other repositories of which they are aware, or their network of contacts to search for terrain databases. Failing that, they often resort to constructing their own terrain database, a time-consuming process that exacerbates the overall problem by increasing the number of databases in the community.

The Battle Command, Simulation & Experimentation Directorate (BCSE) is responsible for the management of M&S within the Army M&S community. As such, it charged the Operations Research Center (ORCEN) in the Department of Systems Engineering (DSE) at the United States Military Academy (USMA) to investigate the current state of terrain database management. Specifically we have studied this problem with the goal of determining which metadata are required to efficiently organize and provide access to these terrain databases. The results of this study are offered for incorporation into the Army Digital Terrain Library (ADTL),

a terrain database (TDB) repository for use by analysts across the Army. In this report, we begin by providing our recommendations. Next we discuss our approach, beginning with a description of the problem and the related systems and initiatives currently in use or under development in the community. Finally, we describe our results and findings and conclude by explaining the rationale for our recommendation to BCSE.

## *1.2 Recommendation*

Based on the research described below, we generated a series of recommendations. First, there should be two sections of metadata about a database: one that is required for entry and another that is optional. The required entries provide enough detail to give an analyst a basic set of database characteristics. They also limit the workload of the individual posting information about a database they created. The optional entries provide much greater detail about a database but would increase the burden of the initial posting. The required entries are:

- Terrain database coordinate system used
- Location represented
- Format (simulation model compatibility)
- Whether roads are represented
- Whether vegetation is represented
- Level of detail of elevation source data
- Level of detail of topography representation
- Application of the database (a viewer or a run-time format)
- Point of contact for the database

The optional entries are:

- Whether structures are represented
- Whether cultural features are represented
- Whether hydrology is represented
- Whether soil types are represented
- Whether littoral features are represented
- Level of detail of cultural source data
- The lineage of the database
- The title of the database
- The publication date of the database

Second, we recommended that this repository have two additional functions: an email reflector and the ability for analysts to post information about a database after they have used it.

The first will allow users to contact each other and truly build a community of users. The second will create a more robust set of information about a particular database.

Currently, we are in the process of populating this framework for the library with terrain databases from a limited number of organizations around the Army. Doing so will allow us to collect a trial set of databases, which is itself a useful product. It will further provide feedback on the metadata so that we may refine it as needed. Other agencies are investigating proposed physical locations for the Army Digital Terrain Library. Following those efforts, the ADTL should continue to be populated, searched and accessed by individuals and organizations from around the Army.

## *1.3 General*

### 1.3.1. Battle Command, Simulation & Experimentation Directorate

The Battle Command, Simulation & Experimentation Directorate, formerly known as the Army Modeling and Simulation Office (AMSO), now has AMSO as one of its three divisions. The BCSE is the Army Proponent for Battle Command, Simulation, Experimentation, Testing and Exercises. In part, it is responsible for M&S oversight and management in the three M&S domains: research, development, and acquisition; advanced concepts requirements; and training exercises and military operations. BCSE is the Army's focal point for integration, analysis, prioritization, and standardization of Battle Command. BCSE also deals with strategy, oversight, investment, and cross-domain integration for M&S activities. Thirdly, it "coordinates, synchronizes, and recommends priorities for concept experimentation, testing and exercise requirements." BCSE also serves as the Functional Area 57 proponent and corresponding civilian career field developer. The directorate is organized into four subordinate groups to accomplish these functions, each one with their own responsibilities. Colonel George Stone is the Director of BCSE and is our client. The organizational diagram is shown in Figure 1 below.

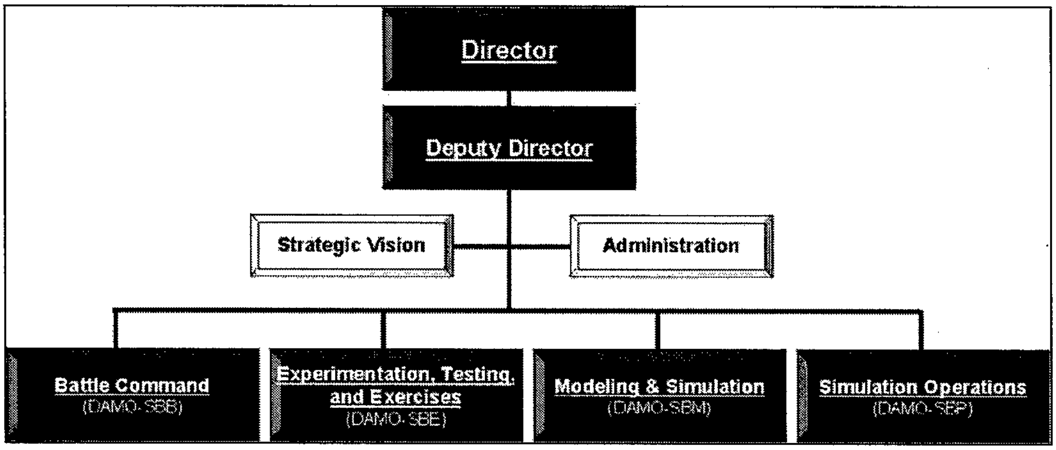


**Figure 1: Battle Command, Simulation and Experimentation Directorate**

## 1.3.2. Systems Engineering and Management Process (SEMP)

The Department of Systems Engineering at the United States Military Academy teaches its cadets the Systems Engineering and Management Process (SEMP) as a problem-solving technique. In conducting this study, we used portions of the SEMP, finishing with the presentation of our recommendation in the Decision Making phase. The SEMP is shown in Figure 2 below.

The first phase of the SEMP, Problem Definition, begins with the initial problem statement, usually taken from the client. Armed with that statement, the analyst begins a

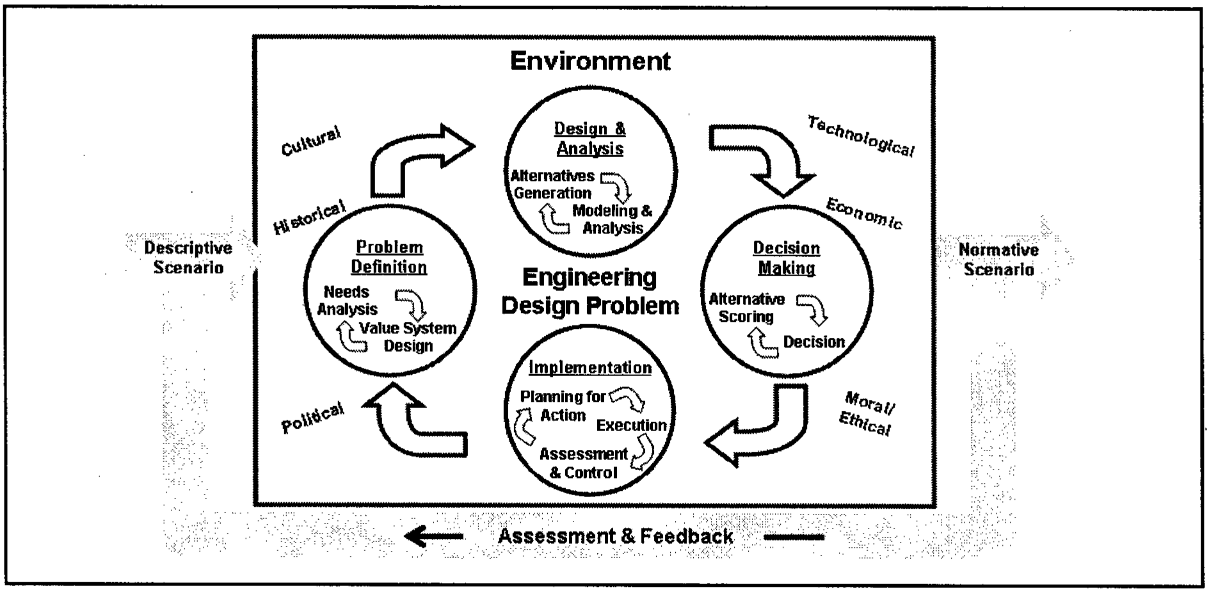


**Figure 2: Systems Engineering and Management Process**

thorough study of the needs of the system. This is largely based upon background research and stakeholder interviews and results in a better understanding of the functions of the system as well as of the environment in which it operates. That process leads to a revised problem statement – a more specific, clearly-defined statement of the client's need. It is also the foundation for the Value System Design, which quantifies the beliefs of the stakeholders as to which functions or capabilities are most important.

Given the revised problem statement and value system design, the analyst enters the second phase, Design and Analysis. Since this is an iterative process, it often is the case that the analyst returns to the Problem Definition phase. This study is no exception; much of the input required in modeling and analysis was provided by the stakeholders identified earlier. Within Design and Analysis, the analyst develops candidate solutions, then uses various techniques to model them to determine their feasibility and effectiveness. Each of the feasible alternatives is then considered against the Value System Design and moves into the third phase of the SEMP, Decision Making. This report will detail our progress up to the decision making phase, since we have concluded this study with our recommendation to BCSE.

# Chapter 2: Problem Definition

## *2.1 Needs analysis*

### 2.1.1. Initial problem statement

In the summer of 2004, the Army Modeling and Simulation Executive Council (AMSEC) "directed the Army Model and Simulation Office (AMSO) to develop an inventory of Army Digital Terrain databases that can be made available to potential users" (Inventory Tasking Memo). In order to accomplish this, AMSO requested that Army analytical agencies compile and send descriptions of each of their TDBs. These TDBs would become part of Army Digital Terrain Library. In August 2004, COL George Stone, Director of the Battle Command, Simulation and Experimentation Directorate (BCSE) (which includes AMSO), asked the Operations Research Center of Excellence at USMA to conduct a study in support of the ADTL. Specifically, our initial problem statement was "compile a list of all Army modeling and simulation terrain databases" with the understanding being that we would apply the SEMP to get

at the stakeholders issues through needs analysis and refine the problem statement. Our statement of work did not include the exhaustive compilation of terrain databases.

### 2.1.2. Initial background research

We began this study by stepping back from that initial problem statement and attempting to break down the problem into its components. This was largely accomplished through discussions with experts in the community, specifically those who deal with environmental aspects of modeling. That provided a greater understanding of related systems and initiatives already underway, or existing, at other agencies.

#### *2.1.2.1 Initial Stakeholder discussions*

There were several important observations from our initial discussions with these stakeholders. First, it was accepted that a repository such as the one conceptualized as the ADTL would be very useful for analysts in the field. Currently, an analyst either must possess a TDB that meets his criteria, contact a colleague who does which can include finding it in an existing repository, or build the database. Therefore, it was initially observed that a repository, one able to be searched and accessed, would be very useful. We confirmed this observation with our first questionnaire.

The second point is that it is also important to know how well a database meets the analyst's criteria for use. Analysts around the Army conduct a wide range of studies, and knowing the specific characteristics of the underlying TDB is critical to the results. Before beginning a study, he needs to know not just if a particular TDB represents a specific location. He must also know what portions of and to what level of detail the environment is represented. The key to this knowledge is the metadata used to describe the database itself.

A third, fairly obvious but no less important observation is that such a repository needed to be easy to use, from both the standpoint of the person reposing a database as well as the person searching for a database. While this is a simple point, it leads in opposing directions. A repository that is easy to populate would allow a person to post a database with a minimum of background information about it. On the other hand, to productively search the repository, a user would like to search on as many characteristics as possible and therefore require a great deal of

background information. Those competing interests have grown into the main thrust of the project.

Fourth, these early discussions broadened our view of the community, since they highlighted the concurrent development of several similar systems. That knowledge led us to more background research about terrain databases, other organizational systems in place or under development. Each of those contributed to a more detailed decomposition of our system.

#### *2.1.2.2 Terrain Databases*

Terrain databases (TDBs) provide the underpinnings for computer combat models. They include required information about a particular geographic location and provide the environmental infrastructure for the conduct of a simulation run – they are the "map" on which the entities operate. Unfortunately, they are much harder to classify or categorize than paper maps for a variety of reasons.

These files can range in size from two to three megabytes for a very general depiction of an area to two to three terabytes or larger for a very detailed representation. While the size of the area represented can vary, in general there are separate files for separate scenario locations, so an analyst may have one TDB for Caspian Sea and another for Fort Benning, Georgia. Furthermore, the differences between databases can be quite significant. The following example contrasts the characteristics of terrain databases with those of a paper map to highlight the challenges.

A map of Fort Benning Georgia can be classified by several features: the type of map (political, road, physical), the level of detail provided (1:12,500 km or 1:50,000 km), or the date of publication for example. However, within each map, the features depicted do not change considerably.

On the other hand, a terrain database of Fort Benning can be categorized by many features and attributes with a variety of enumerations. Each simulation program has its own language or format. That is, the combat models, OneSAF Objective System (OOS), Janus, and Joint Conflict and Tactical Simulation (JCATS) do not use the same TDB formats. Therefore, Fort Benning will be represented in three separate formats, and each one is a separate TDB. Further, there may be different source data used to build the a terrain database, even for the same geographic area. It is plausible to have a database which was constructed from very accurate 10-

meter elevation postings (referred to as DTED 1), less accurate 100-meter postings (DTED-2), or even aerial imagery.

Further complicating the matter, TDBs may represent different features on the ground. One TDB for Fort Benning could represent a specific urban setting very precisely, including roads and buildings with interiors, while representing the surrounding vegetation very simply. Another may include all rivers and creeks, but default their width to a particular dimension to control mobility. Additionally, it is possible for trained users/developers to start with a TDB, then modify it for their needs, based on other sources to increase or simplify detail in certain areas.

The result of all of these potential variations is an uncountable number of terrain databases. For the ADTL to be a useful resource for those in the community, it must be organized with these facts in mind. The key task in its organization, and the motivation for this study, is a structured study of the metadata that is important to those who use TDBs.

#### *2.1.2.3 System decomposition*

It is critical to the SEMP to take a wide view of the initial problem statement. By doing so, we gain a greater appreciation for the true scope of the problem and the environment in which it operates. A key part of doing this is decomposing the system into its component functions, as well as identifying related or parallel systems, as well as supersystems in which the ADTL would operate.

##### ***2.1.2.3.1 Component functions***

Given the initial problem statement, we originally started with the impression that we were developing the entire repository of TDBs and decomposed its functions. The repository could conduct several functions. There must be a method of accessing the databases – a search capability. There must also be a method of entering or reposing the databases. Finally, the repository must contain the databases themselves. We needed to consider each of those in our analysis.

The terrain databases themselves certainly form the content of the repository. That fact led to the question of the storage of those TDBs. Reposing the databases at a single location would allow relative ease of management of the library. However, the size of these files imposes

a significant constraint on the capacity of any system. Further, many TDBs require security measures and release authority. On the other hand, reposing the databases on a distributed system removes the capacity constraint for a single location and allows the individual manager the ability to control access to the database. But doing so also would make it difficult to manage from a centralized location. This is exacerbated by the fact that as individual agencies update file locations or network connections, each such pathway would also have to be updated. In either method, it would be necessary to download a database file, but given their size, doing so is tenuous.

As we considered all of these questions, we returned to our initial problem statement and the impetus for the project. We soon realized, and confirmed in an In-Progress Review (IPR), that our goal was not to build the entire repository. Our project would be an important part of the repository, defining the best metadata for organizing the repository. That metadata would drive the functions of searching for and posting a database. An added functionality for the ADTL that came out of our study was to increase the cross-talk of users in the community.

#### *2.1.2.3.2 Supersystems*

A supersystem is any system that encompasses or provides regulation or direction to another system. One such system to the ADTL is the Army Geospatial Data Integrated Master Plan (AGDIMP). The AGDIMP provides the policy and guidance for management of geospatial data. It describes the Army's overarching strategy for managing geospatial data whether for modeling and simulation or for battle command and communication systems. The ADTL will work within the constructs of the AGDIMP.

Another system with the same type of relationship is the Joint Geospatial Enterprise System (J-GES). Currently under development, the J-GES has the goal of being a distributed repository for global geospatial information for battle command and communications systems. It will be interoperable with all services and will provide a constantly-updated map of virtually any location in the world. Its focus is on providing information to tactical and operational units, potentially to the level of the individual soldier. As modeling and simulation capabilities are more available to deployed units, the ADTL could work within the framework of the J-GES.

A third supersystem to the ADTL is the National Geospatial-Intelligence Agency (NGA). NGA is the country's source of geospatial information, whether it regards political boundaries,

urban specifications or maritime applications. It may provide the source data for building a terrain database. The ADTL will work with and within programs and systems from NGA.

#### *2.1.2.3.3 Parallel systems*

Among parallel systems, it is important to consider that each of these uses their own metadata standard. Therefore, not only is the system itself parallel in nature to the ADTL, its metadata is parallel to the metadata we recommended.

The first of the parallel systems is the Synthetic Environment Data Representation and Interchange Specification (SEDRIS) and the underlying Environmental Data Coding Standard (EDCS). While SEDRIS is not a repository, it does allow the interchange of geospatial data, thereby enabling reuse for different software formats. It is a mechanism that allows for the interpretation of geospatial data from one format to another. Using SEDRIS and the EDCS, a user can describe geospatial data. The EDCS has recently been accepted as International Standard ISO/IEC 18025. The EDCS places environmental features into one of several precisely-defined environmental concepts, then specifies certain values or enumerations for each. We used elements of the EDCS in constructing our stakeholder questionnaires. However, the level of detail made it less desirable for use as our metadata standard, given it would make the initial step of posting a database very time-consuming.

The second similar system is the Master Environmental Library (MEL), which is maintained by the Defense Modeling and Simulation Office (DMSO). The MEL is an internet-based library of terrain resources and is a joint repository of geospatial data, satellite imagery as well as terrain databases. It is a "one-stop site for ordering environmental information." The library includes some terrain databases, but the majority of the holdings seem to work as a repository of satellite imagery and specific environmental data, which would be used to build a separate terrain database. It is functionally similar to the concept of the ADTL, but factors make it less useful to analysts.

The MEL uses Federal Geographic Data Committee (FGDC) Standards as its metadata for organization. Like the EDCS, those FGDC standards are incredibly detailed. Also like the EDCS, they can discourage an individual from posting a database. The result is that there are not many terrain databases in the MEL.

Finally, the third similar system is the Synthetic Natural Environment (SNE) Virtual Data Repository (SVDR). It has the same purpose as the ADTL, but at this point, it is focused on geospatial products for OOS. It is designed to be a virtual repository of 3-dimensional geospatial data for use in combat modeling. The SVDR is still under development by the Science Applications International Corporation (SAIC) in conjunction with/for RDECOM. Nonetheless, the SVDR has great potential for reuse of similar functions or lessons learned in implementing the ADTL. Individuals involved in the SVDR development have been instrumental in this study.

## *2.2 Stakeholder Input*

Based on our initial research, we widened our set of stakeholders to that portion of the modeling and simulation community that deals most closely with terrain databases. A complete list of organizations who were contacted is shown in Appendix B. Our first contact with this wider group was with the first of two questionnaires, followed by a small group session.

### 2.2.1. Questionnaire 1

We distributed the first questionnaire in October by electronic mail to approximately 45 individuals from the organizations listed in Appendix B. Those contacted were asked to input their responses to a number of questions on a web-based form. The purpose of the questionnaire was twofold. First, we wanted to further gather any desired functions of such a repository, as well as provide additional evidence of its value for the community. Second, it was our first chance to get feedback as to what metadata should be included in our solution. We met the first of those objectives completely; for reasons listed below, we had limited success with the second. The questionnaire is shown in Appendix C; the raw results are in Appendix D.

Of the 45 individuals who received the questionnaire, 19 responded. (They are the starred listings in Appendix B.) In general, they all classified themselves as both users and builders of terrain databases. They used a wide range of simulation models, for a variety of purposes and operational scenarios. None used them for simulation of aviation assets, and in general, most were focused at the battalion or brigade-level and higher.

Most interesting were the responses regarding their own libraries of terrain databases. Fourteen of the 19 individuals maintain their own library of databases. If they needed a particular database, either one of a specific location or one with particular features represented,

eight of the 19 would take the time to build a new database. Finally, of the 19 responses, 17 agreed that a registry or repository of databases would be useful, but they desired differing levels of functionality. 13 of the 19 thought the registry would be useful if it provided only a point of contact for the database; 17 of 19 agreed it would be useful if one were able to download the file directly from the registry. These results answered our question of the value of the system to the community. Clearly such a repository would help individuals in the field as they accomplish their tasks.

This question of accessibility was answered by COL Stone in an IPR. In order to maintain security of the files, he specified that the registry would only list the point of contact and would not be a direct file transfer.

To start to determine the significant metadata, we asked the respondents to rank order 19 potential metadata fields from one to 19, with one being most important. Unfortunately, it was not possible to gain any specific insight because the form allowed respondents to list more than one item as a single number. As a result, it was the case that several individuals listed more than one number-one-ranked item. Nonetheless, investigating the results further, we could make some generalizations based on the number of times a particular item was ranked among the top three. In particular, 14 respondents listed the location as one of the three most important details; 12 listed the simulation platform (the format) as among the top three most useful piece of information. Those results are not surprising. Beyond that analysis though, the initial cut at the metadata was not as productive as hoped.

Many respondents added their own comments as to other metadata items that should be included. We incorporated those comments into the workshop and second questionnaire. The comments can be grouped into questions about the features depicted – roads, structures, rivers – and about the detail of the source data. That input helped us considerably in developing the topics for future discussions with these stakeholders.

### 2.2.2. Workshop

After compiling our results of the first questionnaire, we felt it would be important to attempt to gather many of the stakeholders together to discuss individual items of metadata. We did this in a small group setting in conjunction with the Industry/Interservice Training, Simulation & Education Conference (I/ITSEC). Wanting to keep the forum fairly small, we

invited 21 individuals, and eight attended. The purpose of this workshop was to present the results of the first questionnaire, then to focus the discussion on the metadata elements that would be important for inclusion. The format of the meeting also would allow us to capture the relative value of each item of metadata. We split the eight individuals into two groups. Four of the individuals were given the results of the first questionnaire. The other four were given samples of metadata about four databases from the MEL. Both groups had the task of identifying which elements were required, which were redundant, what other detail is needed, and how much more detail should be listed.

Group 1 presented the following observations shown in bulletized form below. They also recommended giving a person a range of options for answering the questions, for example, whether structures are represented could be answered as "no", "in 2-dimensions", or "in 3-dimensions". That recommendation was included in the second questionnaire, found later in the report.

- Redundant items
    - Location and geographical extent
    - Multi-cell and single-cell
- Required items
    - Selection of a naming convention for Location
        - Geographic feature (Fort Hood)
        - Center of Mass (a single latitude / longitude)
        - Boundaries of the "box" (lower-left lat/long, upper-right lat/long)
    - Format (OTB, Janus version x, etc.)
    - Application (System, or Open Flight, etc.)
    - Representation (Grid, TIN or other)
    - Coordinate system
    - Source data with resolution (DTED 1, 2, 3, HRTE 4, 5, 6)
        - Lineage *(if altered)*
    - Features and Attributes
        - Are road networks represented (Yes / No)
        - Are structures represented (No / 2D / 3D)
        - Is vegetation represented
        - Are soil types represented

Group 2 identified that the MEL isn't completely aligned with modeling and simulation products. Further, they added that the metadata (FGDC standards, as mentioned earlier) would likely be a hindrance to anyone posting a database to the repository. One member of the group

commented that having more than about six metadata elements would be an obstacle for him to post his databases. The group offered that a hierarchical structure of the metadata would be required. Finally, they added that it would be useful if an analyst could post information about a database after using it, informally adding to the metadata itself.

They identified the following as important elements that are included in the MEL: (underlined items are the "headings;" each item underneath is a subordinate element of that heading)

- <u>Citation Information</u>
  - Originator
  - Publication date
  - Title
  - Edition
  - Online linkage
  - Publication information
  - Publication Place
  - Publisher
  - Other Citation Details
- <u>Description</u>
  - Abstract
  - Purpose
  - Supplemental Information
  - Time period information (publication date)
- <u>Spatial Domain</u>
  - Bounding Coordinates
- <u>Keywords</u>
  - Theme from MEL_Scientific-Engineering_Field_Thesaurus
  - Place from MEL_Location_Thesaurus
  - Stratum from MEL_Environmental_Domain_Thesaurus
  - Temporal from MEL_Temporal_Coverage_Thesaurus
- <u>Access Constraints</u>
- <u>Use Constraints</u>
- <u>Browse Graphic</u>
- <u>Point of Contact</u>
- <u>Entity and Attribute Information</u>
  - Entity and Attribute Overview
- <u>Data Quality Information</u>
  - Completeness report

They listed the following items as not needed:

- Publication time
- Geospatial Data Presentation Form
- Series Information

- Status
- Entity and Attribute Detail Citation

Each of the group's sets of feedback was significant and considered for inclusion in the second questionnaire. A widely-voiced theme was the observation that the amount of metadata required to post a database would be the key question for the success of the ADTL. It was and has continued to be observed that many metadata fields will result in a very productive search by any analyst, simply because they could search on any of those fields. However, at the same time it was clear that requiring all of those fields of information to be entered would make the initial step of posting a database prohibitive. As noted earlier, one individual specifically said that requiring more than six fields would lead him to post information about a limited number of his databases. Since the success of the library is based on those two factors, they became our driving force for evaluating any proposed model of the metadata. Armed with that, and with the more detailed set of potential metadata fields, we began crafting a second questionnaire. This questionnaire would really allow us to model a candidate solution and receive feedback on the relative merits of each individual field.

## Chapter 3: Modeling and analysis

The modeling and analysis conducted for this study is not precisely aligned with the usual application of modeling and analysis envisioned in the SEMP. In many cases, the modeling and analysis step is the point at which the performance of candidate alternatives is measured and analyzed. Using those results in the decision-making step, each alternative's performance is scored according to the relative value of the functions. However, in this study, the alternatives we were considering were items to be included as part of the metadata. Therefore, our modeling effort consisted of developing a list of metadata items and allowing our stakeholders to express their opinion of each. The functions against which they were measured were the relative ease of posting a database and searching for a database. Having done that, it fell to us to determine how many of the most important items would be included as entries required of someone posting a database.

## *3.1 Questionnaire 2*

Again our method of gathering this information was the use of an online questionnaire. Similar to the first iteration, we distributed an invitation to participate over electronic mail. However, for this portion, COL Stone drafted a memorandum explaining his overall purpose in asking for the input. Prior to distributing the questionnaire though, we conducted more background research as to which features and attributes should be included as potential elements.

### 3.1.1. Finding the right features

Our first questionnaire and the workshop we held provided us a good basis for many questions about the levels of detail of information that could be included (elevation source data resolution, cultural source data resolution, etc.). We considered these a sort of "marginal data," the type of general data found on a paper map that provides the background information of the map. More difficult to choose were which features should be included as potential metadata items – a sort of content data. Roads, structures and vegetation are all features. But we could continue listing items to provide as much added detail as desired. Other features could include wells, bridges and golf courses. Determining where to draw the line became the focus of our work. Unfortunately, there are many different standards for which features should be included in terrain databases. The FGDC certainly established a set with their thematic representation of geospatial data. The Digital Geographic Information Working Group (DGIWG) developed their Features and Attributes Coding Catalog, which is another source. Individual software developers have also established their own set of what features "should" be included in any database of theirs. Finally the Environmental Data Coding Specification (EDCS), also an ISO standard, provides its own detailed description of features. In the end, we considered each of the first three sources, but we focused on the EDCS. In selecting these elements, we reviewed every environmental concept (EC) defined by this standard and selected those that were militarily relevant. You can find questionnaire 2 in Appendix E.

### 3.1.2. Results of questionnaire 2

As mentioned above, we distributed an electronic mail message from COL Stone inviting 55 individuals to respond to this questionnaire. The questionnaire itself was web-based. The organizations targeted were the same as the first questionnaire, with some additions. The list of

organizations is shown at Appendix F; again, those who responded are starred. We again asked the respondents to classify themselves as builders, managers, or users of terrain databases. We also allowed them to select some "other" function. We received 28 responses to the questionnaire, six of whom were builders, four were managers, seven were users, and 11 classified themselves as other. Of those categorizing themselves as other, the responses ranged from someone performing all of the above functions to someone who develops requirements for the simulation systems.

The bulk of the survey was taken up in attempting to determine the best set of metadata fields. We did so by asking the respondents to classify 24 candidate fields as Required, Desired but not required, and Not required. There was no limit to the number of fields that could be classified as required. Appendix G describes the intended meaning of those fields, and you can find the raw results of these questions in Appendix H.

Of the 24 candidate fields, on average a respondent selected 17 of the fields as required. There were no fields that were unanimously classified as required. Likewise, there were none unanimously classified as not required. The results are shown in the table and accompanying figure below.

| Candidate Field | Required | Desired | Not Required | % Required |
|---|---|---|---|---|
| Coordinate System Used | 27 | 1 | 0 | 96% |
| Location | 26 | 2 | 0 | 93% |
| Format | 26 | 1 | 0 | 96% |
| Roads | 24 | 3 | 1 | 86% |
| Vegetation | 24 | 3 | 1 | 86% |
| Elevation Source Data w/Resolutioi | 23 | 5 | 0 | 82% |
| Topography Representation | 22 | 5 | 1 | 79% |
| Structures | 22 | 4 | 2 | 79% |
| POC | 22 | 4 | 2 | 79% |
| Publication Date | 21 | 6 | 1 | 75% |
| Cultural features | 20 | 6 | 2 | 71% |
| Cultural Source Data w/Resolution | 19 | 8 | 1 | 68% |
| Hydrology | 19 | 6 | 3 | 68% |
| Application | 18 | 7 | 2 | 67% |
| Soil Types | 18 | 8 | 2 | 64% |
| Littoral | 18 | 8 | 2 | 64% |
| Lineage | 17 | 8 | 3 | 61% |
| Title | 17 | 9 | 2 | 61% |
| Utilities | 16 | 9 | 3 | 57% |
| Dynamic Terrain | 15 | 11 | 2 | 54% |
| Atmospheric Effects | 14 | 9 | 5 | 50% |
| System reqts. | 14 | 12 | 2 | 50% |
| Originating Agency | 13 | 10 | 5 | 46% |
| SEDRIS-Compliant | 12 | 13 | 3 | 43% |

**Table 1: Raw results from Questionnaire 2**

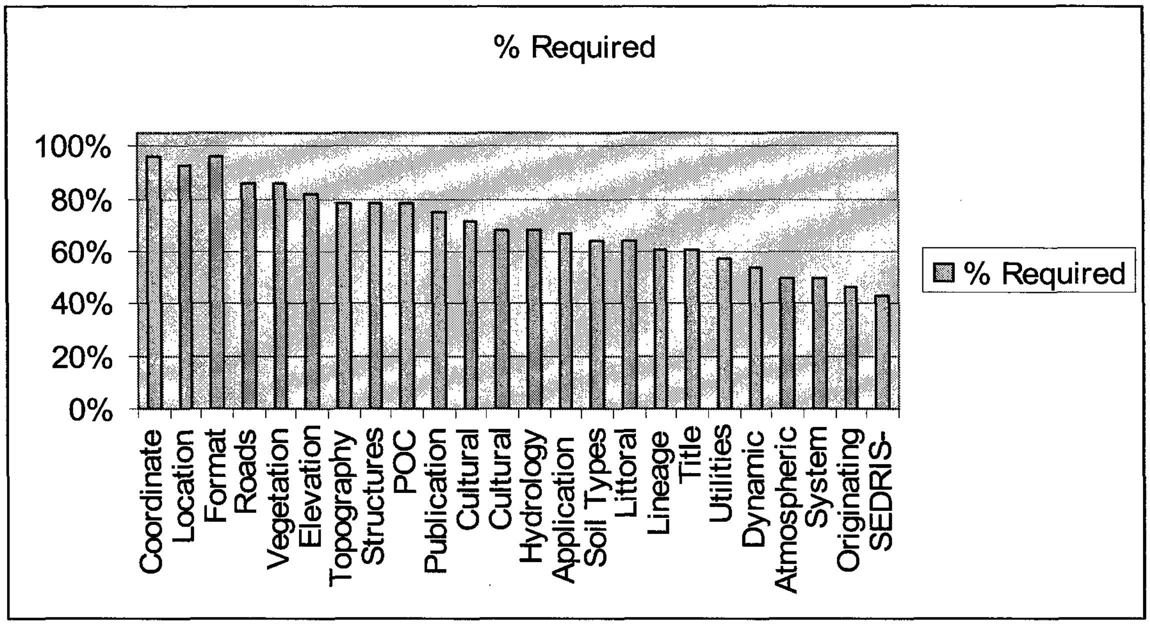


**Figure 3: Raw results, % of respondents who classified as Required**

Additionally, we asked respondents to comment on the value of three other functions which could be available in the ADTL. They rated them from one to five, where five meant they "strongly agreed" that such a function would be useful. First, they were asked whether it would be useful for users to "post" opinions or additional information about a TDB after having used it. Of all respondents, the average score given was 3.9, and eight rated it a 5. Second, they were asked whether it would be useful to have a resource to send an email to other members of a community. All respondents rated this as 4, and 11 rated it 5. Finally, they were asked whether it would be useful to provide additional metadata about a database after using it. Respondents rated this function 3.8 on average, and 10 rated it 5.

Based on our discussion in the small workshop, we also were interested in how respondents were most comfortable describing a particular location. We asked if they would prefer using a specific Geographic Place Name (i.e. Fort Hood), the center of mass of the area represented (latitude / longitude), or the lower-left and upper-right boundaries of the area represented (latitude / longitude). A large majority, 19 respondents, indicated that they were most comfortable describing an area by its boundaries.

## 3.2 *Analysis of Results*

We stepped back from these raw results and wanted to analyze them while considering the overall purpose of the project. It is critical to the Systems Engineering and Management Process to use value-focused thinking in analyzing the results of any project. As we did this for managing terrain databases, we returned to our original thoughts on the functional decomposition of the system, as well as the importance placed on the number of metadata fields that we should select. Finally, COL Stone's focus on the end-user of these databases led us to consider the results from their perspective. We considered each of those factors as we began to analyze the results of the questionnaire and develop our recommendation.

### 3.2.1. Which features to include

As mentioned above, COL Stone desired that we strongly consider the needs and values of the end user of terrain databases. This led us to ask respondents on the questionnaire to classify their roles in the community. However, that classification is not perfect: 10 individuals classified themselves as "other," and some of them stated in the notes that they actually performed all of the roles listed. Further, terrain database builders are also generally database users to some extent. Therefore, while we considered users separately, we did not completely discount the input of any of the respondents. Additionally, the observations of the users as a group are not dissimilar to those of the rest of the respondents.

The first question to answer was the number of metadata fields. Clearly there are the two competing interests. Requiring more fields provides more data and would make the results of a search more useful, but would be an obstacle to easy posting of information. Fewer fields would be easier to post but would decrease the value of any search. We began to answer this question by recalling the observation of one individual at our workshop. Specifically, the individual stated that having any more than six metadata fields would be too many and would lead one to only post those databases that were required. While that observation was not universally agreed-upon at the workshop, those attending generally shared the same opinion in terms of too many fields being an impediment to populating the repository. On the other hand, one key result of questionnaire 2 was the number of fields that were selected as required by the respondents. As mentioned above, an average respondent rated 17 fields as required. Regardless of the observation that more than six was too many, in practice the respondents wanted an average of

17. Since the goal of the study was to find a reasonable number that would still be descriptive, six and 17 became our boundaries. Further, since it is important to promote the posting of the data, remaining closer to the lower bound became more important than approaching the detail provided by 17 fields.

Although that thinking led us to a range of values, it was not prescriptive enough to provide a specific number of fields. However, by investigating the responses, it became possible to determine a series of break points in the responses, based on what percentage of respondents rated a particular field as required. Further, we could separate the user's responses to give another perspective on the problem. We used both of these techniques to develop our recommendation.

First, we considered all the results and looked for natural "break points" in the responses. In a perfect scenario, the responses would follow the Pareto principle, which holds that 80% of contribution would be the result of 20% of the fields. More generally for this project, that a majority of the respondents would select 20% of the fields as necessary, and the other would be considered much less significant. Unfortunately, as you can see from Graph 1, there was no small subset of fields that were most significant. Rather, many of the fields were identified as important. Though there is a small break point at 79%, that by itself does not allow us to assess all those above 79% as required and those below as unimportant. To make a better decision, we considered the responses of those who classified themselves as users of these databases. The results of those seven individuals are summarized in the table and graph below.

| Candidate Field | % Required |
|---|---|
| Coordinate System Used | 100% |
| Location | 100% |
| Format | 100% |
| Topography Representation | 100% |
| Application | 100% |
| Elevation Source Data w/Resolution | 86% |
| POC | 86% |
| Roads | 71% |
| Vegetation | 71% |
| Structures | 71% |
| Publication Date | 71% |
| Cultural features | 57% |
| Cultural Source Data | 57% |
| Hydrology | 57% |
| Soil Types | 57% |
| Dynamic Terrain | 57% |
| Littoral | 43% |
| Lineage | 43% |
| Title | 43% |
| Utilities | 43% |
| Atmospheric Effects | 43% |
| System Requirements | 43% |
| SEDRIS-Compliant | 43% |
| Originating Agency | 29% |

**Table 2: "User" results from Questionnaire 2**

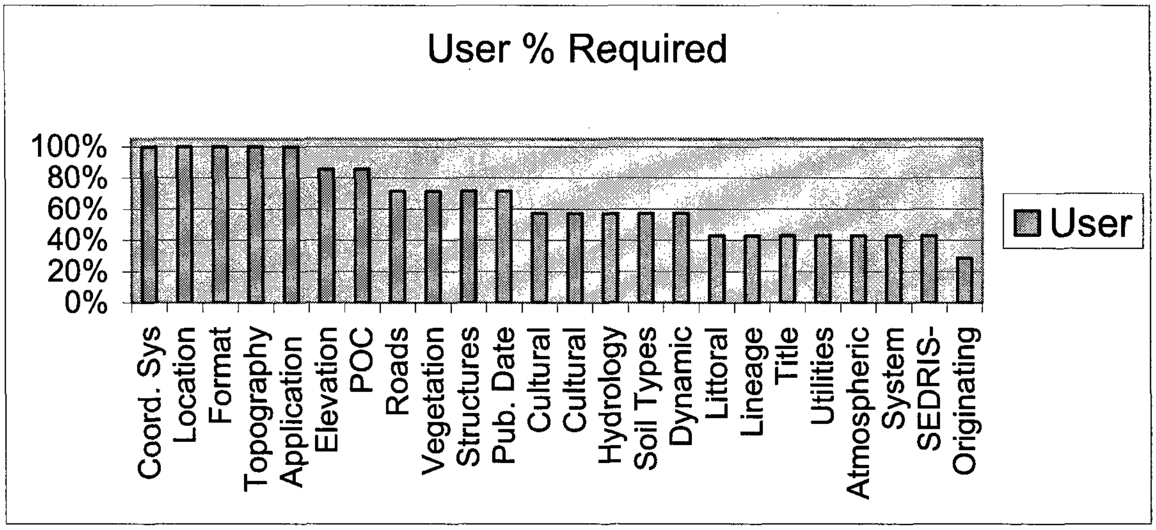


Figure 4: "User" results from Questionnaire 2

Looking at the responses from users, there are some clearer break points in the data. The importance of the first five fields is clear, since they were unanimously rated as required. That also provides the first break point, between those rated as required by all users and those rated required by 86% (six of the seven users). The break points are distinct in the graph above. At the same time though, merely choosing those fields that all users selected as required would give their input more weight than intended. However, using their choices as a starting point and still considering the input of all other respondents allowed us to make a recommendation of which fields should be included for the repository. Further, using the format of a required set and optional set of fields allows us to strike a balance between the detail desired and difficulty of posting the information.

As a result of this thinking, we returned to the initial importance of the user's opinion on COL Stone. Users of terrain databases – analysts from around the Army – would be the benefactors of this system, and therefore we selected those fields that they unanimously rated as required. That gave us five fields: coordinate system used in the database, location represented, format of the database, type of topographic representation, and the application of the database. (For a complete explanation of all the fields listed in this study, see Appendix G.) It is also significant that more than 90% of all other users rated the first three of these as required. 71% and 52% rated the type of topographic representation and application as required. Choosing these fields as required in the repository met the requirement of catering to the needs of the users

of terrain databases. However, we felt it did not adequately represent the needs of others in the field.

To address the needs of those other respondents, we considered the fields that they felt were most important. Looking again at Graph 1 above, there are three candidate fields that more than 80% of other respondents selected as required: whether vegetation is represented (90% of other respondents), the detail of the elevation source data (90%), and whether roads are represented (81%). Also significant is the fact that more than 70% of our users rated these as required. As a third measure of usefulness, only the question of roads was selected as not required by more than 25% of the users. Therefore, these three added candidate fields became part of the recommended required set of metadata. Finally, the point of contact, while not universally accepted as required by the respondents, must be included as part of the metadata, since that is the method of file transmission.

To obtain the list of optional fields, we applied a similar approach. In general, these optional fields provide more of the "content" detail about a database, and consist largely of yes or no questions. Our desire was to find the next set of pertinent facts about a database, as identified by our respondents. To do so, we selected items that were designated as required by more than 60% of the respondents. The associated results are summarized in Table 3 below.

| | **Overall % Required** | **User % Required** | **Other % Required** |
|---|---|---|---|
| Structures | 79% | 71% | 81% |
| Publication Date | 75% | 71% | 76% |
| Cultural features | 71% | 57% | 76% |
| Resolution of Cultural Source Data | 68% | 57% | 71% |
| Hydrology | 68% | 57% | 71% |
| Soil Types | 64% | 57% | 67% |
| Littoral | 64% | 43% | 71% |
| Lineage | 61% | 43% | 67% |
| Title | 61% | 43% | 67% |
| Dynamic Terrain | 54% | 57% | 52% |

**Table 3: Metadata recommended as optional**

### 3.2.2. Which functions to include

Our next question was to determine which of the other proposed functions were deemed worthy of including as part of the repository. There were three options considered. The first of these was the capability of any individual to send an electronic mail message to a number of other people in the field. This is normally referred to as an email reflector. This sort of function is widespread across the military as a valuable method of getting detailed information, especially when the community is geographically dispersed. For each of these results, a score of 5 means that the respondent "strongly agreed" that the function would be useful. For the question of the email reflector, all respondents rated it as 4, and all users rated it 4.43. Given that high rating, we recommended including that function in the repository.

The second function considered was the capability to allow individuals to post comments or additional information about a database after they had worked with it. This is separate from the capability to add to the metadata. Instead, this represents the ability to provide notes about a database which would be visible to any other user. The goal of doing so is to allow these individuals to amplify the description of a particular database, but not have to confirm the validity of the comment. Respondents rated their agreement that this function would be useful as 3.89. Again the users of databases rated it higher, at 4.14. Based on these results, we also recommended including that function in the repository.

Finally, the third function considered was the ability for individuals to add information to the actual metadata of a terrain database. The previously discussed function would merely add a set of comments about a database; this function would allow people to actually change the metadata of a database. The goal of this is again to provide a more accurate metadata than would be provided at the initial step of posting a database. Although the responses were similarly positive to this idea, we did not recommend including this function. We decided that because allowing that sort of modification to the metadata would impose an additional restriction that the "updated metadata" would have to be validated by the original individual posting the information. Having that requirement would be very time-consuming, especially to the original person posting the information. It also could lead to confusing information about a database, if there were several different entries for one. Finally, it is possible that a person using a database would be wrong about the metadata in the first place. For each of those reasons, we decided against recommending that it be included in the repository.

## Chapter 4: Current and future work

After this research, we have recommended the metadata and functions that should be used to organize, manage and search to the terrain databases in the ADTL. Having completed that, there are at least three more phases required to implement the recommendations and have a useful, valuable repository. First, we have begun populating the library with a trial set of locations. Second, after capturing the lessons learned from that initial population, the call needs to go out to the rest of the community to populate the repository with their databases. Finally, there needs to be a plan for and organization responsible for managing the ADTL.

We have already begun the first of these steps, populating the library with an initial set of terrain databases. COL Stone has directed that we contact representatives from Forts Hood, Riley and Knox to have them input information about the terrain databases, and we are in the process of doing so. We have also been in contact with individuals from RDECOM and ERDC-TEC, who will also provide this information about databases they possess. This initial step of implementation will not only begin to gather the information required for the ADTL, it will also allow individuals from around the Army to further refine the metadata selected. As described earlier, the SEMP is an iterative process, and while the metadata for the ADTL will at some point have to be set, we are still open to suggestions for slight modifications that will improve the system.

Following this initial step of collecting information from a limited number of installations and organizations, the ADTL will become widely-available. Once in place, there will be a call for any and all organizations to post information about terrain databases they have on hand. This will also signal the opportunity for other individuals to use the ADTL to find terrain databases that they would like to use. That will lead directly to the long-term management and organization of the repository. Not least of the issues to address at that point will be the question of security and accessibility of the databases.

There is clearly still work to be done before the Army Digital Terrain Library becomes a widely-used and valuable resource for the modeling and simulation community. In this study, we have focused on the metadata and functions required to make that repository worthwhile for the experts in the field. By studying the pertinent background facts about terrain databases and the other related efforts already underway, and by gathering a great deal of input from stakeholders, we have recommended a set of metadata and functions for use in the ADTL.

Ultimately, this recommendation will lead to an important resource for trainers and analysts around the Army who rely on terrain databases to increase the realism and validity of their modeling and simulation.

# Appendix A, Acronyms

| | |
|---|---|
| ADTL | Army Digital Terrain Library |
| AGDIMP | Army Geospatial Data Integrated Master Plan |
| AMSO | Army Modeling and Simulation Office |
| ATEC | Army Test and Evaluation Command |
| BCSE | Battle Command, Simulation and Experimentation Directorate |
| BCTC | Battle Command Training Center |
| CGF | Computer-Generated Force |
| CTSF | Contractor Test Support Facility |
| DFDD | Digital Feature Data Dictionary |
| DGIWG | Digital Geographic Information Working Group |
| DMSO | Defense Modeling and Simulation Office |
| DTED | Digital Terrain Elevation Data |
| DTOP | Digital Topographic Data |
| DTRA | Defense Threat Reduction Agency |
| EC | Environmental Class |
| EDCS | Environmental Data Coding Specification |
| ERDC | Engineer Research and Development Center |
| FACC | Features and Attributes Coding Catalog |
| FGDC | Federal Geographic Data Committee |
| FCS | Future Combat System |
| IITSEC | Interservice / Industry Training, Simulation and Education Conference |
| IPR | In-Progress Review |
| ISO / IEC | International Organization for Standardization / International Electrotechnical Commission |
| JCATS | Joint Conflict and Tactical Simulation |
| JFCOM | Joint Forces Command |
| J-GES | Joint-Geospatial Enterprise Services |
| LSI | Lead System Integrator |
| MANSCEN | Maneuver Support Center |
| MEL | Master Environmental Library |
| MGRS | Military Grid Reference System |
| NGA | National Geospatial Intelligence Agency (formerly National Imagery and Mapping Agency, NIMA) |
| NGIT | Northrup Grumman Information Technology, Inc. |
| NSC | National Simulation Center |
| OOS | Objective One-Semi-Automated Force |
| PEO-STRI | Program Executive Office for Simulation, Training and Instrumentation |
| PM | Project Manager |
| RDECOM | Research, Development and Engineering Command |
| SBL | Soldier Battle Lab |

| | |
|---|---|
| SEDRIS | Synthetic Environment Data Representation and Interchange Specification |
| SNE | Synthetic, Natural Environment |
| SVDR | SNE Virtual Data Repository |
| TDB | Terrain Database |
| TEC | Topographic Engineering Center |
| TIN | Triangulated Irregular Network |
| TPIO | TRADOC Product Integration Office |
| TRAC | TRADOC Analysis Center |
| TRADOC | US Army Training and Doctrine Command |
| TSM | TRADOC System Manager |
| UAMBL | Unit of Action Maneuver Battle Lab |
| USACE | US Army Corps of Engineers |
| USMA | United States Military Academy |
| WSMR | White Sands Missile Range |

# Appendix B, Organizations Targeted by Questionnaire 1

Stars represent organizations who provided a response (some had more than one individual respond)

SBL*

US Army ERDC*

NSC*

PM FCS*

FCS LSI*

MANSCEN*

Boeing*

DTRA*

TRADOC Futures Center*

PEO STRI*

TPIO-Virtual*

TPIO-Terrain Data

NGIT

TRAC-Monterey

# Appendix C, Questionnaire 1

1. Name

2. Organization

3. Email address

4. Phone number

5. Position in organization

6. Purpose of your organization

7. How do you use terrain databases?

- [ ] Build
- [ ] Use

For use in:

- [ ] Analysis
- [ ] Training
- [ ] Wargames
- [ ] Other

8. What simulation platform do you use most of the time?

- [ ] OneSAF
- [ ] WARSIM
- [ ] CombatXXI
- [ ] IWARS
- [ ] IUSS
- [ ] JANUS
- [ ] JCATS
- [ ] Other

9. Which types of forces do you focus on?

- [ ] Dismounted
- [ ] Mounted
- [ ] Aviation
- [ ] Other

10. Which echelon of forces do you focus on?

Brigade or higher  Battalion  Company

Platoon or lower  Other

11. What types of scenarios do you focus on?

Urban  Jungle  Desert  Forest

Other

12. What types of operations?

High-intensity conflict?  Low-intensity conflict  Peacekeeping operations

Other

13. Is there a particular region of the world you use more frequently than any other?

14. Is there a reason for that?

15. Do you maintain a set or catalog of terrain databases for these purposes?

Yes  No

16. If you needed a terrain database for a particular geographic location, how would you get it?

☐ Contact a colleague ☐ Build it myself

☐ Other

17. Would you find it useful to have a "registry" of terrain databases?

☐ Yes ☐ No

18. Would such a registry be adequate if, after searching, it provided the name and email address of a person or organization with the terrain database you're looking for?

☐ Yes ☐ No

Why?

19. Would such a registry be adequate if, after searching, it provided not just the name and email address of a person or organization, but also provided a location from which you could download the database itself?

☐ Yes ☐ No

Why?

20. Please rank the following attributes of such a registry in terms of their importance to you (1: least important --> 4 most important)

☐ Accessibility (how you could get to the registry)

☐ Ease of database distribution (how you would get a particular database)

☐ Ease of data entry/upload (for you to populate a registry with your databases)

☐ Level of detail required for an accurate search (how specific your search terms could be to find a particular database)

21. If you had to search for a terrain database, what characteristic would be easiest for you to search according to? Please rank the following 19 characteristics for their "ease of use" in characterizing a terrain database. A rank of 1 means it is the most descriptive characteristic; a rank of 19 means it is the least descriptive characteristic.

☐ Location

☐ Simulation platform / format

☐ Date created

☐ Lineage

☐ Application (Ground, Flight simulation, Mission planning)

☐ Database type (Visual, SAF, PVD, Radio, Environment Mgr)

☐ Geotypical (notational) or geospecific

☐ Geographic extent (km)

☐ File size (GB)

☐ Source (DTED-2, DFAD, ITD, SEDRIS)

☐ Status (available or under development)

☐ Classification

☐ Cost

☐ Database generation tools used

☐ Export format (SEDRIS, CTDB, S1000)

Platform (PC-based, SGI, ESIG, Motorola)

Release Authority

Technical POC

Notes (defaults added)

22. I know that there are countless variations for the content of a terrain database. I'm trying to capture the most significant and common variations and would appreciate your input as to which those are. For example, it's important to know how a database characterizes soil composition, since there are several possible methods to do so. So at least initially, the method used to describe soil composition should be part of this metadata. Again, I know that this list could be several thousand lines long; I'm looking for the most important subset of that.

23. If you have any other thoughts, questions or suggestions for this project, I would appreciate that input. Thank you again for your time.

# Appendix D, Results of Questionnaire 1

A response of "ON" represents that the respondent selected that choice. We have identified the responses by a number, rather than individual's names. It is possible (and did occur) for a respondent to not enter some information, in which case the block is empty. These results are organized in sections to make the reading clearer.

| | How do you use TDBs? | | | | | | |
|---|---|---|---|---|---|---|---|
| Resp. ID | Build | Use | For Analysis | For Training | For Wargames | Some other use | What is the other use? |
| 1 | ON | | | | | | |
| 2 | ON | ON | ON | ON | ON | | |
| 3 | | ON | | ON | | | |
| 4 | ON | ON | ON | ON | ON | ON | Experimentation |
| 5 | | ON | ON | ON | ON | | |
| 6 | ON | ON | ON | ON | ON | ON | C4 ISR |
| 7 | ON | ON | ON | ON | | ON | Live, virtual and constructive simulation venues |
| 8 | | ON | ON | ON | ON | | |
| 9 | ON | ON | | ON | | | |
| 10 | | ON | ON | ON | ON | | |
| 11 | ON | ON | | ON | | | |
| 12 | ON | ON | ON | | ON | ON | simulation |
| 13 | ON | | | | | | |
| 14 | ON | ON | ON | | | | Training Development & Training by exception (Real World Ranger BN type events) |
| 15 | ON | ON | ON | ON | ON | ON | Battle Command Systems |
| 16 | | ON | ON | | ON | ON | Routing for Unmanned Systems |
| 17 | ON | | | ON | ON | | |
| 18 | | ON | ON | | ON | ON | tactical decision aids, research |
| 19 | | | | | | ON | Look at how space systems collect information to buld terrain databases, and how that information is distributed. |

| Resp. ID | Most Frequently Used Software | Other Software Type Used but not listed |
|---|---|---|
| 1 | Other | My focus is not on building databases for simulation and training. |
| 2 | Other | |
| 3 | Other | CCTT and AVCATT |
| 4 | Other | WALTS, JSAF, IMPACT, HPAC, IMEA |
| 5 | JANUS | |

| | | |
|---|---|---|
| 6 | Other | OneSAF, JointSAF, JWARS |
| 7 | Other | OF OTB (OneSAF is not a fielded system, although we are a beta test site, currently on build 22 - your questionaire is flawed in this regard), also enable use of ATCOM, Firesim, EADSIM, CMS2, SLAMEM, WECAM, ALCES (BLCSE Federates) |
| 8 | OneSAF | multiple |
| 9 | OneSAF | |
| 10 | JANUS | |
| 11 | Other | At this point, I am only building databases so I do not spent much time using the simulation itself |
| 12 | OneSAF | |
| 13 | Other | BBS, CBS, JCATS, JANUS, SPECTRUM |
| 14 | Other | JCATS &OF OTB |
| 15 | OneSAF | |
| 16 | OneSAF | |
| 17 | Other | WARSIM, OneSAF, Combat XXI currently, eventually CTIA, OneTESS, CCTT and AVCATT |
| 18 | OneSAF | |
| 19 | Other | None |

| | Types of forces simulated | | | | |
|---|---|---|---|---|---|
| ID | Dismounted | Mounted | Aviation | Forces Focus Other | Focus Other Text |
| 1 | | | | ON | I work in an R&D environment where we are trying to build basic tools to help with terrain data generation and database management. Do not tailor our work to a specific force. We do have some staff working closely with the SOF, but I am not one of them. |
| 2 | ON | ON | ON | | |
| 3 | ON | ON | ON | | |
| 4 | | | | ON | CBRNE effects on all forces including civilians |
| 5 | | ON | | | |
| 6 | ON | ON | ON | ON | provide data for all purposes |
| 7 | ON | ON | ON | | |
| 8 | | | | ON | all |
| 9 | ON | | | | |
| 10 | ON | ON | ON | | |
| 11 | | | | ON | I assisted my supervisors in building databases for OOS, which is a simulation that focuses on brigade and below echelons. |
| 12 | ON | ON | | | |
| 13 | | | | ON | varies based on needs of requestor |
| 14 | | | | | Infantry with combined arms effects |
| 15 | | ON | | | |

| | | | | | |
|---|---|---|---|---|---|
| 16 | | ON | | | |
| 17 | | | | ON | all of the above |
| 18 | ON | ON | | | |
| 19 | | | | ON | We look at the combined force. |

| | Echelon simulated | | Scenario used most | | | | | |
|---|---|---|---|---|---|---|---|---|
| ID | Echelon simulated | What other echelon? | Urban | Jungle | Desert | Forest | Scenario Focus Other | Scenario |
| 1 | Other | Not appropriate for reasons listed in 10. | | | | | ON | I have been focusing on broad area mapping tools - not specific to urban, jungle, desert, or forest |
| 2 | Other | We cover the gambit | ON | | ON | ON | | |
| 3 | Other | Crew to battalion | | | | | ON | All |
| 4 | Brigade+ | | ON | | ON | ON | | |
| 5 | Brigade+ | | ON | | | ON | ON | Complex terrain such as the mountainous regions of the Caspian Sea area |
| 6 | Other | provide data for all purposes | ON | ON | ON | ON | ON | build data for use in very high resolution to large joint experiments |
| 7 | Other | Although historically focused on BDE and Below (down to individual soldier), recently has been expanded to include BDE and above | ON | | | ON | ON | Geographically large TDBs that end up with all of it (urban canyons, rolling terrain, agriculture, constricted/mountainous, etc) |
| 8 | | | | | | | ON | It varies with the experiment. |
| 9 | Other | Entity to brigade | ON | | | | | |
| 10 | Other | FCS equipped Unit of Action (BCT) | | | | | ON | combination |
| 11 | Other | I used to work in the OneSAF program and now I work for WARSIM. | | | | | ON | At this point I am working with the CCTT P2 database (NTC) which is a desert scenario. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | OneSAF is a brigade and below simulation while WARSIM is a higher echelon simulation. | | | | | | |
| 12 | Company | | ON | | ON | ON | | |
| 13 | Other | ALL | | | | | ON | ALL |
| 14 | Other | BDE and below | | | | | ON | Heavy focus on urban but all are included |
| 15 | Platoon- | | ON | | | | | |
| 16 | Platoon- | | ON | ON | ON | ON | | |
| 17 | Other | WARSIM- Division to Echelon above Corps, OneSAF- Brigade and Below | | | | | ON | All of the above as defined by OneSAF/WARSIM data model |
| 18 | Company | | ON | ON | ON | ON | ON | a variety of scenarios to test environmental effects |
| 19 | Brigade+ | | ON | ON | ON | ON | | |

| Types of Operations | | | | | |
|---|---|---|---|---|---|
| ID | HIC | LIC | Peacekeeping | Simulate other types of operations? | What other types of operations? |
| 1 | | | | ON | Again, I myself do not directly support individual units or build databases for specific types of operations. However, TEC does have workunits dedicated to feature extraction in an urban environment and tactical decision aids in an urban environment. Urban conflict is seen as a research area where much work needs to be done. |
| 2 | ON | ON | ON | ON | |
| 3 | | | | ON | all |
| 4 | ON | ON | ON | ON | Terrorist attack response, Industrial accidents |
| 5 | ON | | ON | | |
| 6 | ON | ON | ON | ON | All purposes |
| 7 | ON | ON | ON | | |
| 8 | | | | ON | it varies with the experiment. |
| 9 | ON | ON | ON | | |
| 10 | ON | | | | |
| 11 | | | | ON | |
| 12 | ON | ON | | | |
| 13 | | | | ON | ALL, including Homeland Security |

| | | | | | |
|---|---|---|---|---|---|
| 14 | | | | | ALL |
| 15 | | ON | | | |
| 16 | ON | | | | |
| 17 | | | | ON | All of the above |
| 18 | ON | ON | ON | | |
| 19 | ON | | | | |

| | Location | | If you need a database | | | | |
|---|---|---|---|---|---|---|---|
| Resp. ID | Region of World | Reason for Region of World | Maintain own library? | Would you contact colleague? | Would you build yourself? | Would you use some other means? | What other means? |
| 1 | Not particularly. | | Yes | Yes | No | No | |
| 2 | Not Really, It depends on what the customer wants | It depends on what the customer wants | Yes | Yes | Yes | Yes | Contact NGA |
| 3 | Middle East | OEF/OIF | No | Yes | No | Yes | |
| 4 | Southwest USA. | Primary area used for JFCOM distributed training and experimentation events. | Yes | Yes | Yes | No | |
| 5 | Caspian Sea | Scenario used in CGSOC | Yes | Yes | No | Yes | Utilize databases provided by CGSOC |
| 6 | No, We have built the world at a very low resolution and then build higher resolution inserts of the AOI | To play multiple exercises all over the world at once in networked environment | Yes | No | Yes | No | |
| 7 | Most of the last 3 years has been spent over Azerbaijan, with some work in CONUS | DPG/FCS scenarios | Yes | No | Yes | No | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | and elsewhere | | | | | | |
| 8 | Currently its the Middle East, but could vary. | Current opns focus to incorporate lessons learned. | Yes | Yes | No | No | |
| 9 | | | No | Yes | Yes | No | |
| 10 | Casapian | TRADOC approved scenario | No | Yes | No | No | |
| 11 | At this point I am working on P2, so I would say the area at Ft Irwin (NTC). | I am working with the conversion of a P2 (CCTT NTC) database to an OTF (OOS terrain format). | No | Yes | No | No | |
| 12 | Caspian Sea | TRADOC compliancy | Yes | Yes | Yes | No | |
| 13 | no | Our users are from different organizations all over the world | Yes | No | Yes | Yes | depends on simulation |
| 14 | Most of our scenarios use DPG compliant scenarios | Required for analysis | Yes | No | Yes | No | Would get source code and already built databases from whomever and modify accordingly to suit our requirements typically requires development of high fidelity urban areas to include MES. |
| 15 | SWA | Most hostile | Yes | Yes | No | No | |
| 16 | MidEast Germany Central America | Past, Present, and Future conflicts | Yes | Yes | No | No | |
| 17 | Southwest Asia, CONUS | SWA is temporary/intermittent for current conflicts. CONUS is ongoing for home station training. | Yes | No | No | Yes | First resort would be to survey the community for existing TDB meeting requirements, or build a |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | new one as last resort depending on urgency of requirmeent. |
| 18 | No | | Yes | Yes | No | Yes | Identify what resources (tdbs) we already have |
| 19 | No | No | No | Yes | No | No | |

| | Value of registry | | | | |
|---|---|---|---|---|---|
| ID | Would a registry be useful? | Would it be useful if it provided only POC? | Why or why not? | Would a registry that allowed you to download a TDB be useful? | Why or why not? |
| 1 | Yes | Yes | It would help TEC be more efficient. We would not have to dedicate resources to build products that already exist. It would also allow us to value-add to these products as opposed to building all datasets from scratch. This also increases efficiency. | Yes | I think the ability to download the database would have to be crucial to success. Otherwise, efficiency is compromised if CDs have to be burned or FedExed. What would even be better is if we could work with the data directly without even downloading - such as in a distributed Internet environment. More and more GIS software is moving towards an enterprise environment where the data is distribute across a network. Downloading all this data may be very time comsuming. However, if you can access the data remotely and work with it at your PC, that would be the paradigm I'd move towards. Something like ArcIMS. |
| 2 | Yes | No | If such a resitry existed and the POC info was provided that would be helpful but not operationlly adeqaute. | Yes | |
| 3 | Yes | Yes | So you could contact the POC and get it. | Yes | |
| 4 | Yes | No | It could take too long to get the database and compatibility can be an issue. Often the person identified is on travel or no | Yes | One wouldn't have to wait for the POC to be in the office. Transfer device compatilibility is no longer an issue. However, both offices need decent size communication |

| | | | | | |
|---|---|---|---|---|---|
| | | | longer in the same position. Many databases are larger than what can be put on a CD or even DVD. Often such databases need to be shipped via a hard drive. The databases could be on a UNIX or SGI machine supporting one office, but the requesting office needs the database on a Windows machine. Providing the data on a compatible transfer medium can be a problem. | | pipes to download a large database, typically overnight. Comments on Question 21 below: The metadata associated with such a registry are the key to making it work and all the attributes mentioned are of interest. However, I don't see myself searching on many of those attributes, so I only ranked the items I thought I might use in a search. |
| 5 | Yes | Yes | The key is the ability to transfer that data base through the appropriate electronic means (classified versus unclassified). The NIPRNET and SIPRNET pipes are very limited. | Yes | See answer to question 18. |
| 6 | Yes | Yes | I have a large set of terrain data that I provide for others to obtain. I'm the POC for OneSAF terrain. See: http://mel.dmso.mil Select HTML Query Set Data Source TEC - USACE Set number of records to display at 100 Select Begin Data Query Visualize Bounding areas shows the areas that I distribute and Alternative Access provides a means to order data | Yes | Web pages are needed on both classified and unclassified systems. An email alone would not be good as people change jobs and the link to the data is lost. |
| 7 | No | Yes | You really need a "Maybe" choice. There's sometimes more to this than just contacting who has it on disk. There may be distribution restrictions on the | Yes | Again, depending on 17 and comments provided in 18 - but certainly, ease of access would increase probability of subsequent use if the TDB met requirements. COMMENT on 20 - you assume that there are many databases that are of |

| | | | | | |
|---|---|---|---|---|---|
| | | | source used, on components of the product itself, etc. This is before you examine #17, which is why it may not be useful, which would then make 18 and the following questions below a moot point. | | true use/value. That certainly would contribute to the ranking/answers of 20 and below. |
| 8 | Yes | No | we would need to know about the data, its resolution, format & storage to know if it was useable to us. | Yes | That would be better. Then we could look to see if it fit our needs before downloading it. |
| 9 | Yes | Yes | It could be helpful if the database was of the resolution and content that was needed and also in a format that allowed for translation/conversion into desired format. | Yes | |
| 10 | No | No | | No | |
| 11 | Yes | Yes | I could contact the person and ask more questions about the database to make sure it is suited to my needs. | Yes | It would accelerate the process of getting the database, especially for mission rehearsal scenarios. |
| 12 | Yes | Yes | | Yes | |
| 13 | Yes | Yes | We currently do that for all constructive terrain generated in the NSC, although we are not the only ones who generate terrain or edit terrain. | Yes | We are currently trying to work this issue here, but due to security limitations, have been unable to come up with an acceptable system. |
| 14 | Yes | Yes | | Yes | |
| 15 | Yes | Yes | | Yes | |
| 16 | Yes | No | Would perfer to have a direct source to determine accuracy of terrain and post directly to site. There is a potential to have several individuals on the registry posting several different versions of the same terrain database. | Yes | This is slightly better, but the problems still exist determining accuracy of the terrain database. |
| 17 | Yes | Yes | Locating the database is the most difficult part of the | Yes | Download would be more useful but not essential. |

| | | | | | |
|---|---|---|---|---|---|
| | | | problem since there is no exhaustive central registry that exists today. Current searches tend to be very ad hoc and haphazard. | | |
| 18 | Yes | Yes | Because I could use that to contact the person and determine whether the database was suitable "out of the box" for our needs, whether it was pretty close, or whether it was not useful | Yes | Because I could use that to contact the person and determine whether the database was suitable "out of the box" for our needs, whether it was pretty close, or whether it was not useful - OR - I could download that database and determine potentially easily for myself |
| 19 | No | No | N/A | No | N/A |

| | How important are these attributes of a registry? (1-4, 4 is most important) | | | |
|---|---|---|---|---|
| ID | Accessibility | Ease of DB distribution | Ease of data entry / upload | Level of detail required |
| 1 | 2 | 3 | 4 | 1 |
| 2 | 4 | 2 | 3 | 3 |
| 3 | 2 | 3 | 4 | 1 |
| 4 | 2 | 3 | 1 | 4 |
| 5 | 2 | 1 | 3 | 4 |
| 6 | 4 | 4 | 4 | 4 |
| 7 | 4 | 3 | 1 | 3 |
| 8 | 1 | 2 | 3 | 4 |
| 9 | 3 | 1 | 4 | 2 |
| 10 | 3 | 1 | 4 | 2 |
| 11 | 1 | 2 | 4 | 3 |
| 12 | 4 | 4 | 4 | 3 |
| 13 | 1 | 3 | 2 | 4 |
| 14 | 2 | 1 | | 3 |
| 15 | 1 | 2 | 3 | 4 |
| 16 | 4 | 3 | 2 | 1 |
| 17 | 2 | 4 | 3 | 1 |
| 18 | 1 | 3 | 4 | 2 |
| 19 | | | | |

The following results are split into two sections, again for clarity.

| | Rate these according to their importance as metadata, 1-19, 1 is most important | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ID | Location | Simulation Platform | Date Created | Lineage | Source | Application | DB Type | Geotypical or Geospecific | Geo Extent | File Size |
| 1 | 3 | 12 | 7 | 6 | | 11 | 10 | 5 | 2 | 13 |
| 2 | 4 | 18 | 5 | 8 | | 9 | 17 | 2 | 3 | 13 |
| 3 | 1 | 2 | 16 | 15 | | 3 | 4 | 11 | 14 | 17 |
| 4 | 1 | 2 | 6 | | | 8 | 4 | 9 | 10 | 11 |
| 5 | 1 | 13 | 12 | 14 | | 11 | 2 | 3 | 4 | 15 |
| 6 | 1 | 2 | 12 | 14 | | 13 | 3 | 11 | 4 | 9 |
| 7 | 1 | 1 | 6 | 5 | | 3 | 3 | 5 | 1 | 15 |
| 8 | 1 | 2 | 15 | 13 | | 3 | 12 | 4 | 17 | 16 |
| 9 | 15 | 5 | 10 | 14 | | 12 | 3 | 4 | 1 | 9 |
| 10 | 1 | 6 | 13 | 17 | | 2 | 5 | 4 | 9 | 8 |
| 11 | 1 | 2 | 8 | 19 | | 4 | 3 | 16 | 7 | 10 |
| 12 | 1 | 2 | 19 | 18 | | 3 | 4 | 17 | 5 | 16 |
| 13 | 1 | 2 | 3 | 10 | | 11 | 12 | 7 | 4 | 8 |
| 14 | 1 | 5 | | | | | 6 | 7 | | |
| 15 | 5 | 1 | 6 | 7 | | 4 | 10 | 8 | 9 | 11 |
| 16 | 4 | 2 | 17 | 18 | | 16 | 3 | 8 | 5 | 15 |
| 17 | 1 | 2 | 17 | 16 | | 15 | 4 | 14 | 3 | 13 |
| 18 | 1 | 2 | 9 | 16 | | 17 | 5 | 6 | 4 | 12 |
| 19 | | | | | | | | | | |

(continuation of previous responses)

| | Rate these according to their importance as metadata, 1-19, 1 is most important | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ID | Source2 | Status | Classification | Cost | DB Generation Tools | Export Format | Platform | Release Authority | Technical POC | Notes |
| 1 | 1 | 4 | 9 | 14 | 18 | 8 | 15 | 16 | 17 | 19 |
| 2 | 1 | 15 | 14 | 12 | 19 | 10 | 11 | 7 | 6 | 16 |
| 3 | 5 | 6 | 18 | 19 | 10 | 7 | 9 | 13 | 8 | 12 |
| 4 | 12 | | 7 | | | 3 | 5 | | | |
| 5 | 9 | 10 | 5 | 19 | 8 | 6 | 7 | 18 | 16 | 17 |
| 6 | 10 | 15 | 5 | 18 | 17 | 6 | 7 | 8 | 16 | 19 |
| 7 | 7 | 3 | 3 | 3 | 10 | 7 | 7 | 6 | 18 | 11 |
| 8 | 5 | 6 | 7 | 18 | 8 | 9 | 14 | 10 | 11 | 19 |
| 9 | 2 | 19 | 6 | 17 | 11 | 7 | 13 | 8 | 16 | 18 |
| 10 | 16 | 7 | 3 | 10 | 14 | 15 | 11 | 12 | 18 | 19 |
| 11 | 6 | 11 | 12 | 13 | 9 | 5 | 14 | 18 | 15 | 17 |
| 12 | 15 | 6 | 7 | 14 | 13 | 8 | 12 | 9 | 10 | 11 |
| 13 | 5 | 9 | 6 | 19 | 13 | 14 | 15 | 16 | 17 | 18 |
| 14 | 3 | | 4 | 2 | | | | | | |
| 15 | 3 | 2 | 12 | 16 | 13 | 15 | 14 | 17 | 18 | 19 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 14 | 1 | 7 | 18 | 19 | 6 | 9 | 10 | 11 | 12 |
| 17 | 5 | 6 | 18 | 12 | 7 | 8 | 9 | 10 | 11 | 19 |
| 18 | 10 | 3 | 13 | 18 | 11 | 7 | 8 | 15 | 14 | 19 |
| 19 | | | | | | | | | | |

| ID | Common TDB Variations | Additional Comments |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | DTED versus HRTE - each have varying degrees of accuracy Method of collection - SRT versus imagery, etc Method of compilation Classification system - ie soil example stated in question | |
| 6 | What was the source and resolution of the linear and areal feature data. What was the source of the imagery used and what was the resolution. What was the source of the elevation data and what was the resolution. Are the features integrated into the surface? ie: Do the roads lay flat? Is the surface gridded or tinned? Is the data releaseable to DoD and DoD contractors only? What are the formats of the data for a geographic region? What is the size of each data set for that geographic region? Is the data multicell or single cell? Are the 3d models geospecific, geotypical or both? Are the 3d models Multiple Elevation Structures (MES) structures or not? What software would you typically use to display the data? | I've got two web sites that provide the type of access that you are considering developing. They are sponsored by the Defense Modeling and Simulation Office and the site is called the Master Environmental Library. http://mel.dmso.mil http://mel.nrl-mry.navy.smil.mil |
| 7 | Good luck - this is really as much a function of the runtime/federate as it is of the TDB itself. Elevation source and resulting construct Cultural source, content and use Geotypical vice geospecific Soil/water/vegation Buildings and density Airfields and representation Ports and representation This doesn't answer your question probably, but I'm stopping here. You could almost choose to use some sort of adaptation of the FACC list and just check off what's there as a start point. | TDBs that would meet BLCSE requirements are generally measured today in 10s of Gbs. This is not an FTP type transaction for most users. Some of the premise of this study may not be applicable to power users or users that require geographically large, yet complex/robust TDBs/environments. You will always have to consider how these are handled from a source data (specifically NGA) and other potential licensing issues of the end product. Neither of these are well understood by the majority of the community, nor have they been historically followed to any degree (at least in my experience). No one uses S1000 anymore (or they shouldn't be or God Bless them if they are). Likewise, I think your survey is SEDRIS biased as that remains a non-factor, at least for us. The term export format is a little confusing as |

| | | |
|---|---|---|
| | | well - do you really mean runtime format (which is absent from the list)? Platform is confusing as this is really more related to run time format (ctdb, flight, Janus, etc). |
| 8 | Not sure of the question being asked. Could you clarify? | A helpful addendum for the registry would be the available data conversion sofware with descriptions of transformations achievable by using each and which simulations they are typically paired with. Also, extent and types of metadata associated with each data set would be nice as well. |
| 9 | What data model is used to represent the features of the terrain database. What type of triangulation method is used - gridded vs irregular TINs. Integrated features or applique (overlayed) features. | |
| 10 | MAJ Martin - I'm not sure how I got identified as a 'key stakeholder'. My only experience with databases was as a player or user during my military career (UCOFT, SIMNET, CCTT, JANUS, BBS, CBS). In my work on the FCS program I've been involved in several discussions regarding data and data bases. I don't have a preference other than the specific needs of the warfighter - can he access, manipulate and display the data? Does the data have the required resolution/fidelity in terms of elevation data and feature data? Can the warfighter update the data base with more current or 'better data' collected by the warfighter (organic sensors). This probably isn't much help but its the best I can offer for now. TJ Smith | |
| 11 | Common Variations. -Format of the data (SEDRIS, OTF, CTDB etc). -Regular TIN (CCTT) vs ITIN (OTF). -Are roads integrated in the terrain database? -Polygon Attribution. -Spatial Reference Frames used in the different databases. -Given a SEDRIS (STF) database, is the terrain skin represented as a regular grid or as an Integrated Triangulated Irregular Network (ITIN)? | I think that the most important part of a database repository would be detailed metadata that could support complex queries which are always needed to find a database suited for a particular purpose. |
| 12 | The effects due to terrain are most important to us. | None |
| 13 | Those which are important to our location were included in question 21. | NOTE on questoin 21 - Only about the 1st 6-7 characteristice are applicable to our location, so from about 8 on, they are just ranked in order of a appearance, not need. |
| 14 | Urban area fidelity | It would be very difficult for us to populate this database with terrain we have built. Many are sensitive in nature or are proprietary. |
| 15 | Slope Vegetation Buildings Obtacles Roads Soil Streams/Rivers Water | |
| 16 | Not sure I see a question here but I believe you are asking what are the important attributions. This depends of the level of detail and the size unit we are studying. Assuming I understand the question here it | Talk to Paul Dykes, He is building the global soils data base for NGA. Paul T. Dyke Blackland Research Center Texas A&M University |

| | | |
|---|---|---|
| | goes. Standard ITD data attributions Soil %sand %silt %clay %Moisture Content (at time database was created) %Hydraulic Conductivity of the Soil at Saturation %Tension at Saturation %Macro Pore Structure, Torturosity Elevation Vegetation Tree Type Bush Type Grass Type Density vs stem spacing Obstacles Surface Roughness (for radar and vehicle ride) Temperature Brightness Emissivity between 8 and 14 microns Rivers Depth Width Streams Depth Width | System 720 East Blackland Road Temple, Texas 76502 e-mail dyke@brc.tamus.edu Phone:254-774-6059 (office) Phone:254-774-6000 (secretary) Fax:254-774-6001 Talk to https://afweather.afwa.af.mil/ as they keep a ground moisture map of the world. Talk to NGA and TEC. Niki can give you POC at these sites, but Nancy Gardner is a good individual Talk to Fort Knox Major (RET) Joe Burns who is creating the database for SAF at Knox. And of course there is JAUS which is the DOD organization for comunication between Unmanned Systems. But they have not worked on how to communicate terrain between systems. Hope this helps |
| 17 | Number one is more detail on source data, e.g.,: Elevation data source: - NGA DTED Level 1/2, etc - RTV High Resolution Terrain Elevation (HRTE) Level 4/5, etc. - USGS DEM/Granularity - other Feature data source: - NGA VMAP Level 0 (1:1,000,000 scale) Level 1 (1:250,000 scale) Level 2 (1:50,000 scale), Urban Vector Map (1:12,500 scale), etc. - NGA DTOP/MSD Level 1-5 - NGA ITD/PITD/VITD, etc. - RTV shape files - other sources/format Imagery data source: - NGA CIB 1-30 (meter) - commercial imagery/source/granularity - other sources/granulariy Cartographic Source products - NGA CADRG/scale - other sources/scale For export formats, delineate candidates: - NGA VPF - ESRI Shape Files - SEDRIS Transmittal Format (STF) - MultiGen OpenFlight - etc. | A very good start. An admin note, in addition to submit/reset, it would be a good idea to have a third option to "save" the project if someone wishes to continue work later. At one time, I felt the download capability would be very important, but with database sizes increasing, it should be adequate to simply give the option for ftp for smaller databases or for larger ones, FedEx/USMail depending on urgency. |
| 18 | - I believe it would be useful to have the capability to determine whether certain features are avialable in a terrain database (e.g., dams, bridges, tunnels); It would also be useful to know what the source data is for these features or whether/how the data was inferred - I believe it would also be useful to know whether the terrain database contained buildings and whether these buildings had interiors (can DI enter the building, e.g.) - As far as classification systems for features, I would say: (a) soil type (b) bridge load classification (c) building material/construction (what a building is principally constructed from) | |
| 19 | | |

# Appendix E, Questionnaire 2

My name is Major Grant Martin, and I am an analyst in the Operations Research Center in the Department of Systems Engineering at the United States Military Academy. I am conducting a study on behalf of COL Stone, Director of the Battle Command, Simulation and Experimentation Directorate (BCSE), formerly AMSO. The purpose of the study is to identify the metadata needed to efficiently organize and provide access to modeling and simulation terrain databases. This is the second and final questionnaire which will be used in the study. The goal of this questionnaire is to gather feedback from experts in the field as to which metadata are truly important and would be beneficial in managing these databases. You received this because you were identified as an important individual in this field. Your input is critical to the development of a useful product for the modeling and simulation community. I appreciate your taking the time to provide your answers. If you have any questions or would like more information about this study, please feel free to contact me at phillip.martin@usma.edu or (845) 938-5661.

1. Name:

2. Organization:

3. Email address:

4. Phone number:

5. In working with terrain databases, how would you describe your primary role? (please choose only one)

A. Terrain Database Builder
B. Terrain Database User
C. Terrain Database Manager
D. Other (please specify below)

If you selected D. Other:

6. In working with terrain databases, do you have a secondary role? (please choose only one)

A. Terrain Database Builder
B. Terrain Database User
C. Terrain Database Manager
D. Other (please specify below)

If you selected D. Other:

7. How long have you worked with terrain databases?

A. 0-1 Years
B. 1-5 Years
C. 5+ Years

8. On a scale of 1-5, how would you describe your level of experience in working with terrain databases? (1 denotes little experience, 5 denotes much experience)

1
2
3
4
5

9. As you answer the following questions about required or desired fields of metadata, please consider that this metadata framework will be used by people with a variety of needs:

A terrain database manager who will use this framework to maintain their agency's terrain databases;

An analyst who would use a terrain database as part of a simulation study who will use the framework to search for a particular terrain database;

A terrain database builder who will repose his or her databases here.

Please also consider the types of analysis you have done or will do in the future. Based on your experience, which of the following would be "Required entries," which would be "Not required," and which would be "Not required, but desired?"

Please simply mark:

R for a required item
NR for a not required item
D for a not required (but desired) item

Please mark all items. Each entry can only have one mark.

R
NR
D Location

R
NR
D Format (Janus version, OneSAF, JCATS, etc.)

R
NR
D Application (System, Open Flight, etc)

R
NR
D Topography Representation (Grid, TIN, other)

R
NR
D Terrain database coordinate system used

R
NR
D Elevation source data with resolution (DTED 1, 2, 3, HRTE 4, 5, 6 or equivalent)

R
NR
D Cultural source data with resolution (DTOP 1, 2, 3, 4, 5 or equivalent)

R
NR
D Originating agency (USATEC)

R
NR
D Lineage (history of changes you've made to the DB)

R
NR
D Publication date

R
NR
D Title

R
NR
D Are road networks depicted? Yes/No

R
NR
D Are structures depicted? No/2D/3D

R
NR
D Is vegetation depicted? Yes/No

R
NR
D Are soil types depicted? Yes/No

R
NR
D Are cultural features (churches, hospitals, etc) depicted? Yes/No

R
NR
D Is hydrology depicted? Yes/No

R
NR
D Are littoral features depicted? Yes/No

R
NR
D

Are utilities depicted? (sewers, power lines) Yes/No

R
NR
D

Are atmospheric effects depicted? Yes/No/NA

R
NR
D

Is dynamic terrain represented? Yes / No

R
NR
D

Is it SEDRIS-compliant? Yes / No

R
NR
D

System (hardware / software) requirements

R
NR
D

Point of contact

10. Of other features and attributes that could be included in this metadata, are there some that you believe should be included, either as a required or optional entry?

11. How are you most comfortable describing or searching for a location of a terrain database?

A. Geographic Place Name (e.g. Fort Hood)
B. Center of Mass (a single latitude / longitude)
C. Boundaries (low er-left, upper-right latitude / longitude)

12. Please rate the following statements from 1 to 5, 1 meaning you strongly disagree, 5 meaning you strongly agree, 3 means you neither agree nor disagree.

a. It would be useful to have the ability for users to "post" opinions or useful information about a particular terrain database after using it.

1
2
3
4
5

b. It would be useful to have an email reflector so that you could post a question about the availability of a database to a wide audience in the community.

1
2
3
4
5

c. It would be useful to have the ability to provide additional metadata about a terrain database after using it.

1
2
3
4
5

# Appendix F, Organizations Targeted by Questionnaire 2

Stars represent organizations who provided a response (some had more than one individual respond)

Boeing*

Contractor Test Support Facility (CTSF)

Department of Geography and Environmental Engineering, USMA*

DTRA*

FCS LSI*

Future Combat System Lead System Integrator and Training Integrated Product Team (FCS LSI and Training IPT)*

MANSCEN*

Natick Soldier Center*

National Geospatial Intelligence Agency (NGA)*

NGIT*

NSC*

PEO STRI*

PM FCS*

RDECOM

SBL*

TPIO-Virtual*

TPIO-Terrain Data*

TPIO-Battle Command*

TRAC-Monterey

TRAC-WSMR*

TRADOC Futures Center*

UAMBL

US Army ERDC-TEC*

# Appendix G, Explanation of Fields in Questionnaire 2

| | |
|---|---|
| Are structures represented | Does the database represent man-made structures? |
| Publication date | What was the original date of creation of this database? |
| Are cultural features represented | Does the database represent features such as churches, hospitals, schools? |
| Is hydrology represented | Does the database represent hydrologic features, such as rivers, lakes, as well as the adjoining land (riverbanks)? |
| Cultural source data | What is the level of detail of cultural source data (DTOP level)? |
| Are soil types represented | Does the database represent varied soil types? |
| Are littoral features represented | Does the database represent elements common to coastal features? |
| Lineage | (If needed) what is the history of changes to this database? What was the original database, and how have you or others you know of altered it? |
| Title | What is the name of the database? |
| Are atmospheric effects represented | Does the database represent atmospheric effects such as weather, wind, fog? |
| SEDRIS-compliant | Is the database compatible for SEDRIS conversion? |
| Coordinate system | Is the database organized by latitude, longitude or the Military Grid Reference System? |
| Format | What software platform (OOS, JCATS) does this database support? |

| | |
|---|---|
| Location | What is the location represented? |
| Are roads represented | Does the database represent roads? |
| Is vegetation represented | Does the database represent vegetation? |
| Elevation source data | What is the base elevation source data (DTED levels)? |
| Point of Contact | Who is the individual responsible for the database? Who would one contact to request it? |
| Topography representation | Is the database organized in a grid system, or are the elevation postings in Triangulated Irregular Networks (TINs)? |
| Application | Is the database in a run-time format or a viewing file? Can a computer-generated force interact with the elements represented? |
| Are utilities represented | Does the database represent utilities such as power or telephone lines or sewers? |
| Is dynamic terrain represented | Does the database represent the effects of battlefield action (rubble, craters)? |
| Originating agency | What is the original source of the database? |
| System requirements | What hardware or software requirements must be met to use this database? |

# Appendix H, Results of Questionnaire 2

Again we have identified the responses by a number, rather than individual's names. It is possible (and did occur) for a respondent to not enter some information, in which case the block is empty. These results are organized in sections to make the reading clearer.

## Background information about the respondents

| Resp. ID | Primary Role | Other Primary Role | Secondary Role | Other Secondary Role | Time Working With TDBs | Experience Level (5 is high) |
|---|---|---|---|---|---|---|
| 1 | C. Terrain Database Manager | | A. Terrain Database Builder | | C. 5+ Years | 4 |
| 2 | D. Other (please specify below) | DoD M&S Terrain Executive Agent | D. Other (please specify below) | GEOINT Standards for Terrain Data | C. 5+ Years | 5 |
| 3 | C. Terrain Database Manager | | A. Terrain Database Builder | | C. 5+ Years | 5 |
| 4 | B. Terrain Database User | | A. Terrain Database Builder | | C. 5+ Years | 2 |
| 5 | A. Terrain Database Builder | | D. Other (please specify below) | Terrain Database Integrator | C. 5+ Years | 5 |
| 6 | D. Other (please specify below) | I build, use, and manage | D. Other (please specify below) | My roles switch around | C. 5+ Years | 3 |
| 7 | A. Terrain Database Builder | | B. Terrain Database User | | C. 5+ Years | 4 |
| 8 | B. Terrain Database User | | C. Terrain Database Manager | | C. 5+ Years | 4 |
| 9 | D. Other (please specify below) | Terrain Database requirements for C2 systems | A. Terrain Database Builder | Terrain Database requirements forsimualtions | C. 5+ Years | 2 |
| 10 | C. Terrain Database Manager | All of the above really | A. Terrain Database Builder | I am also a user | C. 5+ Years | 4 |
| 11 | B. Terrain Database User | | C. Terrain Database Manager | | C. 5+ Years | 5 |
| 12 | D. Other (please specify | other | D. Other (please specify | other | A. 0-1 Years | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | below) | | below) | | | |
| 13 | C. Terrain Database Manager | | B. Terrain Database User | | B. 1-5 Years | 3 |
| 14 | A. Terrain Database Builder | | B. Terrain Database User | | C. 5+ Years | 5 |
| 15 | D. Other (please specify below) | Geospatial Engineer | B. Terrain Database User | | B. 1-5 Years | 2 |
| 16 | D. Other (please specify below) | Education | B. Terrain Database User | | C. 5+ Years | 5 |
| 17 | A. Terrain Database Builder | | C. Terrain Database Manager | | C. 5+ Years | 4 |
| 18 | D. Other (please specify below) | Subject matter expert w/ 20 yrs exp | B. Terrain Database User | | C. 5+ Years | 5 |
| 19 | D. Other (please specify below) | Combat Developer - Joint National Training Capability | D. Other (please specify below) | Integration of Terrain Data into the LVC-IA | B. 1-5 Years | 3 |
| 20 | D. Other (please specify below) | Analyst for system capabilities and requirements | A. Terrain Database Builder | | C. 5+ Years | 2 |
| 21 | B. Terrain Database User | | C. Terrain Database Manager | | C. 5+ Years | 3 |
| 22 | B. Terrain Database User | | A. Terrain Database Builder | | B. 1-5 Years | 4 |
| 23 | D. Other (please specify below) | Software Developer | B. Terrain Database User | | C. 5+ Years | 3 |
| 24 | B. Terrain Database User | | A. Terrain Database Builder | | C. 5+ Years | 5 |
| 25 | A. Terrain Database Builder | | C. Terrain Database Manager | | C. 5+ Years | 5 |
| 26 | A. Terrain Database Builder | | C. Terrain Database Manager | | C. 5+ Years | 3 |
| 27 | B. Terrain Database User | | A. Terrain Database Builder | | C. 5+ Years | 4 |
| 28 | D. Other (please | Requirements definer | C. Terrain Database | | C. 5+ Years | 5 |

| | specify below) | | Manager | | | |
|---|---|---|---|---|---|---|

Selection of fields as Required (R), Desired (D), or Not Required (NR) (organized in several sections)

| Resp. ID | Location | Format (Janus, OOS) | Application | Topography Rep. | Coordinate System Used | Elevation Source Data w/Resolution | Cultural Source Data w/Resolution |
|---|---|---|---|---|---|---|---|
| 1 | D | R | R | R | R | D | D |
| 2 | R | R | D | R | R | R | R |
| 3 | R | R | R | R | R | R | R |
| 4 | R | R | R | R | R | R | R |
| 5 | R | R | R | R | R | R | R |
| 6 | R | R | D | D | R | D | D |
| 7 | R | R | D | R | R | R | R |
| 8 | R | R | R | R | R | R | R |
| 9 | R | D | D | R | R | R | D |
| 10 | R | R | NR | R | R | R | R |
| 11 | R | R | R | R | R | R | R |
| 12 | R | | | R | R | R | R |
| 13 | R | R | R | D | R | R | R |
| 14 | D | R | D | D | R | R | R |
| 15 | R | R | R | R | R | R | R |
| 16 | R | R | R | R | R | R | D |
| 17 | R | R | R | D | R | D | D |
| 18 | R | R | R | R | R | R | R |
| 19 | R | R | R | R | R | R | R |
| 20 | R | R | R | R | R | R | R |
| 21 | R | R | R | R | R | R | D |
| 22 | R | R | R | R | R | R | NR |
| 23 | R | R | D | R | R | D | D |
| 24 | R | R | R | R | R | R | R |
| 25 | R | R | NR | NR | R | R | R |
| 26 | R | R | R | R | R | R | R |
| 27 | R | R | R | R | R | D | D |
| 28 | R | R | D | D | D | R | R |

| Resp. ID | Originating Agency | Lineage | Pub. Date | Title | Roads | Structures | Vegetation |
|---|---|---|---|---|---|---|---|
| 1 | D | D | D | D | R | R | R |
| 2 | R | R | R | R | R | R | R |
| 3 | R | R | R | R | R | R | R |
| 4 | D | R | R | D | R | R | R |
| 5 | R | R | R | R | R | R | R |
| 6 | NR | R | R | R | R | R | R |
| 7 | R | R | R | R | R | R | R |
| 8 | R | D | R | D | R | R | R |
| 9 | D | NR | D | D | R | D | R |
| 10 | R | R | R | R | D | D | D |
| 11 | NR | R | R | R | R | R | R |
| 12 | D | R | R | R | R | R | R |
| 13 | D | D | D | D | R | R | R |
| 14 | NR | R | R | R | R | R | R |
| 15 | R | R | R | R | R | NR | R |
| 16 | R | R | R | R | R | R | R |
| 17 | R | D | R | NR | D | D | D |
| 18 | NR | NR | R | R | R | R | R |
| 19 | R | R | R | R | R | R | R |
| 20 | R | R | R | R | R | R | R |
| 21 | D | D | R | R | R | R | R |
| 22 | NR | NR | NR | D | D | D | D |
| 23 | D | D | D | NR | R | R | R |
| 24 | R | R | R | R | NR | NR | NR |
| 25 | R | R | R | R | R | R | R |
| 26 | D | D | D | D | R | R | R |
| 27 | D | D | D | D | R | R | R |
| 28 | D | R | R | D | R | R | R |

| Resp. ID | Soil Types | Cultural features | Hydrology | Littoral | Utilities | Atmospheric Effects | Dynamic Terrain |
|---|---|---|---|---|---|---|---|
| 1 | R | R | R | D | D | D | D |
| 2 | R | R | R | R | R | R | R |
| 3 | R | R | R | R | R | R | R |
| 4 | R | R | R | R | R | R | R |
| 5 | R | R | R | R | R | R | R |
| 6 | R | R | R | R | R | R | R |
| 7 | R | R | R | R | R | R | R |
| 8 | R | R | R | R | R | R | R |
| 9 | D | D | R | R | D | NR | D |
| 10 | D | D | D | D | D | D | D |
| 11 | R | R | R | R | R | R | R |
| 12 | D | R | R | R | R | R | R |
| 13 | R | R | D | R | D | R | D |
| 14 | R | R | R | R | R | D | D |
| 15 | NR | NR | NR | NR | NR | NR | R |
| 16 | R | R | R | R | R | D | D |
| 17 | D | D | D | D | D | D | D |
| 18 | R | R | R | R | R | R | R |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19 | D | R | D | D | R | R | R |
| 20 | R | R | R | R | NR | NR | R |
| 21 | D | D | D | D | D | NR | D |
| 22 | D | R | NR | D | D | D | D |
| 23 | R | R | R | R | R | R | NR |
| 24 | NR | NR | NR | NR | NR | NR | R |
| 25 | D | D | D | D | D | D | D |
| 26 | R | R | R | R | R | D | D |
| 27 | R | D | R | D | D | D | NR |
| 28 | R | R | R | R | R | R | R |

| Resp. ID | SEDRIS-Compliant | System reqts. | POC | Most comfortable describing or searching for a location | Provide comments about a database (5 is best) | Email reflector (5 is best) | Provide additional metadata after using it (5 is best) |
|---|---|---|---|---|---|---|---|
| 1 | D | R | D | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 5 | 5 |
| 2 | R | R | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 5 | 5 | 5 |
| 3 | NR | R | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 1 | 5 | 1 |
| 4 | R | D | R | A. Geographic Place Name (e.g. Fort Hood) | 4 | 5 | 4 |
| 5 | R | R | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 5 | 5 | 5 |
| 6 | R | R | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 5 | 5 | 5 |
| 7 | D | R | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 5 | 4 | 5 |
| 8 | R | D | R | A. Geographic Place Name (e.g. Fort Hood) | 5 | 5 | 5 |
| 9 | D | D | NR | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 4 | 4 |
| 10 | D | D | D | C. Boundaries (lower-left, upper-right latitude / longitude) | 5 | 2 | 5 |
| 11 | D | R | NR | C. Boundaries (lower-left, upper-right latitude / longitude) | 5 | 5 | 5 |
| 12 | NR | D | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 2 | 2 |
| 13 | D | R | R | A. Geographic Place Name (e.g. Fort Hood) | 4 | 4 | 3 |
| 14 | D | NR | R | C. Boundaries (lower-left, upper-right latitude | 5 | 5 | 3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | / longitude) | | | |
| 15 | R | R | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 4 | 5 |
| 16 | D | D | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 4 | 5 |
| 17 | R | NR | R | A. Geographic Place Name (e.g. Fort Hood) | 3 | 3 | 4 |
| 18 | R | R | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 2 | 1 | 1 |
| 19 | D | R | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 4 | 3 |
| 20 | R | R | R | A. Geographic Place Name (e.g. Fort Hood) | 4 | 5 | 4 |
| 21 | NR | R | R | B. Center of Mass (a single latitude / longitude) | 3 | 3 | 4 |
| 22 | D | D | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 4 | 4 |
| 23 | D | D | D | C. Boundaries (lower-left, upper-right latitude / longitude) | 3 | 5 | 2 |
| 24 | R | R | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 4 | 4 |
| 25 | R | D | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 1 | 1 | 1 |
| 26 | D | D | D | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 4 | 4 |
| 27 | D | D | R | B. Center of Mass (a single latitude / longitude) | 4 | 5 | 4 |
| 28 | R | D | R | C. Boundaries (lower-left, upper-right latitude / longitude) | 4 | 4 | 4 |

| Resp. ID | Other Features |
|---|---|
| 1 | |
| 2 | Intended use being met by the database developer, goes beyond a system name and should not list Openflight or other interchange format in this area (should be as specific as possible but even broad statements like, training, analysis, acquisition, OT&E, mission rehearsal, planning, and operations can be useful). Full specification of location to include reference datum as well as coordinate system. Feature data dictionary that was used (FACC, FADD, DFDD, NFDD, EDCS, IHO S-57, or ASCII Text). Databse size (data volume) and organization (themes) and if tiled. Databse Preview capability available (what software and where to look). Data rights issues / databse owner / sponsor, which could be different from POC. Need category to describe the surface representation (TIN, TRN, Splines etc.) as well as source |

| | |
|---|---|
| | DEM (describe), DTED 1,2, HRTe 3-7 or? Feature data format (shapefiles 2d or 3D, VPF, SLF, Openflight, country database, or?) Any value adding to source data should be captured as well as classification or restricted distribution issues this ideally would provide information down to the attribute / attribute value - enumeration level. All sources need identified to include elevation, features, all names used (with location for fuzzy features like mountain ranges, deserts, river systems etc.), Is the database available in a pre-runtime format as well as runtime? Information on any associated 3D Model and textures libraries that were used. What weather data is to be used as input for weather effects modeling? Littoral effects models and associated source data for long shore current, rip tides etc. What tools (like DTSim) are used for dynamic effects in all domains (terrain, ocean, atmosphere)? If the database was designed to interface with a simulation federation, what environmental server was it providing information to or receiving information from? |
| 3 | |
| 4 | |
| 5 | All features and attributes required for compliance with applicable Federal Geographic Data Committee (FGDC) and International Organization for Standardization (ISO) standards for metadata. |
| 6 | |
| 7 | |
| 8 | As an optional entry, it would be good to have information further detailing features (such as soils or vegetation) by classification systems used. In other words, are soils enumerated/designated as USCS categories, is vegetation an areal feature using ITD vegetation themes, etc. Another useful but not required entry would be metadata on why the terrain database was created - for a particular study, for an experiment such as DARPA MC2, and the purpose. This could help orient the potential user about the focus for geotypical or geospecific date and areas of emphasis (forests, urban, ..) Metadata on resolution of features (such as soils based on FAO 1:1M ...) would also be useful (but not required) |
| 9 | |
| 10 | Projection used in developing database Datum used in developing database Source material used in compilation date of source material Date of compilation |
| 11 | |
| 12 | |
| 13 | Comment on questionare: The examples for Format and Application are misleading and generally reversed. I would argue that Open Flight is a format used my many applications (although orginally created by Multi-Gen for their visual application) and that OneSAF, JCATS are applications (which sometimes have proprietary formats which may be the format as well. |
| 14 | |
| 15 | All data needs to be injested from standard NGA formats and regenrerated from the M&S box3s without additional error |
| 16 | The datum used is required. The item that says "Terrain database coordinate system used" is vague about this point. |
| 17 | |
| 18 | |
| 19 | |
| 20 | Validity level for individual pieces of data or if not possible, for the entire set (has data been generated to fill a gap, surrogated, supplied by humint, derived using multiple sources, etc.) Images or digital photos of cultural features. Availability in multiple formats. Stability of individual pieces of data. |
| 21 | A need exists to list Terrain DB supporting tools and any license fees associated with supporting tools necessary to support Terrain database use. For example, OneSAF may have the capability to impart feature data into the proposed OTF format using the EDM and other components of SEDRIS but it does not help if they are not populated. One would have to purchase COTS tools, become proficient with the tool, obtain required data (if not available) and then populate the feature data as needed - hoping it would work as advertised. |
| 22 | |

| | |
|---|---|
| 23 | Atmospheric effects are usually considered a separate simulation component or physical model. Similarly, dynamic terrain effects are usually implemented in the simulation terrain runtime component, not in the terrain database file: Other metadata to consider include: Location format (lat/long, UTM, UPS, geocentric, tile relative), Longitude zone (even if UTM is not used), Map Datum, is terrain paged or tiled?, size of the page or tile (meters, lat/long extents, size in bytes), number of polygons, number of linear vector features, number of vector feature vertices, average and maximum polygon density (polygons per sq Km). |
| 24 | The only reason I marked NR on many of the items is that I think they should not be stated as Y/N but briefly described by source and process. |
| 25 | |
| 26 | |
| 27 | |
| 28 | The Training IPT has developed a list of over 800 features and 900 attributes that are required for Training in FCS. This does not include the urban area. Those features and attributes will be added to the list mentioned above between now and mid summer. That requirements list with its pedigree (mapped to Unit of Action Missions, then to the Military Functions is available to you. Also, pedigree to FCS ORD and SoS Specification is available. |

(Basics of DTED) http://www.fas.org/irp/program/core/dted.htm

# Bibliography


Federal Geographic Data Committee, "Content Standard for Digital Geospatial Metadata Workbook (For use with FGDC-STD-001-1998), Version 2.0," May 1, 2000, available at www.fgdc.gov/publications/ documents/metadata/workbook/_0501_bmk.pdf. Accessed 21 July 2005.

McCarthy, D.J., McFadden, W.J., and McGinnis, M.L., "Put Me in Coach, I'm Ready to Play! A Discussion of an Evolving Curriculum in Systems Engineering," *Proceedings of the 13th Annual International Symposium of INCOSE*, Washington, D.C., 493-501, 2003.

Office of the Deputy Chief of Staff of the Army, G3/5/7, *Army Digital Terrain Library – DRAFT*, September 2004.

Stevens, Dan, "Terrain Database Generation - An Introduction," available at http://www.sisostds.org/webletter/siso/iss_74/art_328.htm. Accessed 21 July 2005.


## Online resources used


www.amso.army.mil (General information regarding the Battle Command, Simulation and Experimentation Directorate)

http://www.amso.army.mil/agdimp (Website for the Army Geospatial Data Integrated Master Plan)

http://www.digest.org/html/gp40.htm (Website of the FACC developed by the DGIWG)

https://mel.dmso.mil/ (Website for the Master Environmental Library)

http://www.fas.org/irp/program/core/dted.htm (Discussion of DTED values)

http://www.geospatial-online.com/geospatialsolutions/static/staticHtml.jsp?id=10083 (Glossary of geospatial acronyms)

http://www.nga.mil/portal/site/nga01/index.jsp?epi-content=GENERIC&itemID=b5c86591e1b3af00VgnVCMServer23727a95RCRD&beanID=1629630080&viewID=Article (Website that describes the National Geospatial Intelligence Agency)

http://www.sedris.org/index.htm (Website for Synthetic Environment Data Representation and Interchange Specification)

http://www.sedris.org/wg8home/Documents/18025_FDIS/C030810E.html (Website that provides the environmental codes used in EDCS)

# Distribution List

| NAME/AGENCY | ADDRESS | COPIES |
|---|---|---|
| Author(s) | MAJ Grant Martin<br>Dr. Niki Goerger<br>LTC Jeffrey Schamburg<br>LTC Michael Kwinn<br>Department of Systems Engineering<br>Mahan Hall<br>West Point, NY 10996 | 4 |
| Client | COL George Stone<br>LTC Scott Schutzmeister<br>Mr. Ed Curle<br>Battle Command, Simulation and Experimentation Directorate<br>HQDA, Office of the Deputy Chief of Staff, G-3/7 (ATTN: DAMO-SB)<br>400 Army Pentagon<br>Washington, DC 20310-0400 | 3 |
| Dean, USMA | Office of the Dean<br>Building 600<br>West Point, NY 10996 | 1 |
| Defense Technical Information Center (DTIC) | ATTN: DTIC-O<br>Defense Technical Information Center<br>8725 John J. Kingman Rd, Suite 0944<br>Fort Belvoir, VA 22060-6218 | 1 |
| Department Head-DSE | COL Michael McGinnis<br>Department of Systems Engineering<br>Mahan Hall<br>West Point, NY 10996 | 1 |
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# Chapter 5: REPORT DOCUMENTATION PAGE – SF298

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DSE-TR-0504

**5e. TASK NUMBER**

**5f. WORK UNIT NUMBER**
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Operations Research Center
Department of Systems Engineering
US Military Academy
West Point, NY 10996

**8. PERFORMING ORGANIZATION REPORT NUMBER**
DSE-R-0504

**9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
Battle Command, Simulation and Experimentation Directorate
HQDA, Office of the Deputy Chief of Staff, G-3/7 (ATTN: DAMO-SB)
400 Army Pentagon
Washington, DC 20310-0400

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**11. SPONSOR/MONITOR'S REPORT NUMBER(S)**

**12. DISTRIBUTION / AVAILABILITY STATEMENT**
Distribution A: Approved for public release; distribution is unlimited.

**13. SUPPLEMENTARY NOTES**

**14. ABSTRACT**
The modeling and simulation (M&S) community relies on terrain databases to provide the underpinnings that drive analysis, acquisition, and training. Terrain database generation is cost and time prohibitive. Furthermore, the problem of organizing these terrain databases is much more difficult than maintaining a catalog of paper maps. Reuse of terrain databases is hampered by the difficulty in identifying and accessing existing terrain databases with potential for reuse. Terrain databases not only vary by the geographic extents which they encompass but also vary by terrain database format as required by different simulation programs and platforms, by the amount of detail in terms of features and attributes contained, and by the resolution and fidelity among other factors. Thus, there may be several different terrain databases for the same geographic location but not all may be useful for particular M&S or for specific studies and analysis. This report discusses the application of the Systems Engineering and Management Process (SEMP), taught by the Department of Systems Engineering at the United States Military Academy, in developing a metadata framework for organizing these terrain databases as a means to facilitate reuse and reduce redundancy. Specifically, we focus on choosing among potentially dozens of descriptive metadata fields, considering the need for easy search capability as well as initial data entry. We also discuss related initiatives within the community.

**15. SUBJECT TERMS**
Terrain database management; metadata; knowledge management

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